THE ENGINEERING MAGAZINE

THE WORLD IS ITS FIELD

VOL. XXVI. JANUARY, 1904. NO. 4.

THE SOLUTION OF THE ISTHMIAN-CANAL PROBLEM.

By Gen. Henry L. Abbot.

General Abbot is beyond question one of the foremost authorities upon the physical problems of the Panama Canal—especially the Chagres problem which is the key to the entire project. His study of that question which appeared in this Magazine in December, 1902, was not only (to quote Mr. Morison's expression in a contribution to these pages just one year ago) "of an exhaustive character and of the greatest value." It was more—a complete demonstration of the soundness of the choice of the Panama route as the best for an Isthmian canal.

General Abbot has been so sure of the unassailable strength of this position that he has always chosen to demonstrate it, rather than to enter into controversial discussion of any other route. It is therefore of very great interest, now that the determination is beyond controversy (except probably the assaults of Senator Morgan and others of his type), to have this calm and distinct expression of GeneralAbbot 's opinion of the Nicaragua route, judged absolutely and by comparison with that which has been chosen for the great work.—THE EDITORS.

NOW that the smoke of the battle which has so long clouded the projected Isthmian-canal problem has cleared away, it is not without utility to consider the dangers escaped by choosing the route by Panama. For many years this route was considered as pre-empted by France, and the United States could only hope to secure the second best which was believed to be that by Nicaragua. This latter route had been repeatedly examined, and finally, in 1899, with some misgivings on the part of those best informed in the matter, Congress had nearly decided to take decisive action and begin the work of construction. Never was there a more conspicuous illustration of the wisdom of the old adage *festina lente*. Now that the peril is passed, and in the light of the important developments made known since that date by the labors of the Isthmian Canal Commission, we can calmly and without exaggeration consider what sort of a canal we were about to undertake.

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The first point for consideration in judging of the merit of a projected canal is the facility of approach for large vessels. Natural harbors do not exist in Nicaragua, but this statement does not fully cover the case. On the Pacific coast one may be excavated and probably maintained at moderate cost, but on the Atlantic coast a never-ending battle with the forces of nature is inevitable. Fifty years ago a good harbor existed at Greytown, and lines of steamers connected it with New York and New Orleans. Now it has become a lagoon, shut in by the advancing sand movement occasioned by winds and waves acting upon the materials transported in vast quantities by the San Carlos and Serapiqui rivers from the volcanic region where they take their rise. We have learned by experience on the South Atlantic, Gulf, and Pacific coasts of the United States what such a struggle with nature means. Costly works of improvement, annual outlay for dredging, and liability to temporary closure by violent storms such as are not infrequent in this tropical region, must be contemplated.

The general characteristics of the inland district to be traversed next demand attention. Central America has long been the home of volcanoes. Lake Nicaragua itself owes its separation from the Pacific, and its elevation to a height exceeding 100 feet, to some convulsion of a former geologic age. The earthquake of 1844 raised upon it waves which caused immense damages on the banks; and ships following the canal route must pass in the close vicinity of an active volcano, Ometepe, which had a violent eruption in 1883. We have recent and conclusive evidence as to the lack of stability of the earth crust at San Jose de Costa Rica, about sixty miles from the eastern locks of the projected canal, furnished by the reports of the Director of the Institute Fisico-Geografico, there established. From January 1, 1901, to September 30, 1903, a period of 33 consecutive months, these official records show 39 slight tremors, 73 slight shocks, and 33 strong shocks, the decided movements continuing for 14 minutes and 43 seconds. Similar observations made at Panama for the same period show 6 slight tremors and 3 slight shocks, the movements continuing for about 10 seconds. The delicate adjustments of the lock gates of a ship canal are liable to injuries from such movements, entailing delays in transit, while the more violent disturbances which have recently occurred in other parts of Central America could hardly fail to close a canal for long periods. Common sense dictates that the canal should not be placed in the region of greatest danger from earthquakes to be found any where upon the continent, when a safer and better route exists elsewhere.

But there are other general characteristics of the region traversed by the Nicaragua route which show it to be ill suited to the transit of ocean shipping. Such are the strong trade winds that sweep through the gorge of the San Juan river at all seasons of the year. The difficulty in directing the ship would be further increased by the phenomenal rainfall near the Atlantic coast, where it is greater than at any other point on the American continent. The annual average is from 260 to 270 inches, and 25 feet are of record at Greytown, where there is no definite dry season; rain may be expected any day in the year. In the western or lake section the rainfall is much less, being annually about 65 inches, and favored by a well defined dry season. The safety of ship-canal navigation is largely dependent on clear vision, especially by night, and this the conditions existing near the Atlantic coast certainly do not favor. Another serious difficulty would result from the fact that ships must follow the tortuous course of the San Juan river for nearly 50 miles, and although the Isthmian Canal Commission has given careful study to the subject it has been found impossible to reduce the curvature to the limit that experience on the Suez canal has shown to be demanded for easy transit. Furthermore, the channel of the river must carry to the sea all the drainage of about 12,000 square miles of territory, causing at times currents prejudicial to navigation, and complicated by eddies at the mouths of the principal tributaries, of which the Sabalos river is the most important. In fine, then, this long river route, exceeding in length the entire distance from ocean to ocean by the Panama line, must remain subject to the combined effects of strong winds, sharp curvature, and longitudinal and cross currents, to say nothing of the obscuration due to heavy rainfall. It may well be doubted whether any system of artificial lighting could render night transit safe for large ships, and without it delays and possible congestion could hardly be avoided.

No little stress has been laid by the advocates of the Nicaragua route upon the advantages furnished by the great lake that forms a part of it for about 70 miles. The fact has been ignored that about 29 miles of this distance lie through an artificial channel to be excavated in soft mud, where supplementary dredging may often be required; and that about a mile and a half of the western portion must be blasted through rock. The cost of opening this part of the route has been estimated by the Isthmian Canal Commission at nearly $8,000,000, and the chances of touching bottom when the ships are subject to the strong winds and waves that prevail on the lake may well be considered.

But it remains to consider what from an engineering point of view

would be perhaps the most serious objection to the Nicaragua route if completed and opened to traffic. This would be the risk of longer or shorter interruptions liable to result from the complicated system of water supply in seasons of drought of long duration, and the lake lies in a district where they are far from uncommon. It has been claimed that a vast lake about 3,000 square miles in extent must furnish an ideal source of supply, but the matter will bear a little examination. By the dam on the lower San Juan river the channel of the present stream would be transformed into an arm of the lake, maintained sensibly at the same level, and through this arm all shipping must pass, the depth of water depending wholly on the stand of the lake. This stand is now subject to a natural oscillation of about 13 feet. Under the projected conditions the entire outflow must pass over the dam at a distance of about 50 miles from the main lake, and if the level is allowed to rise above the present high-water stand, valuable lands under cultivation on the west shore of the lake would be flooded and claims for damages would result. On the other hand, the bed of the river is crossed by many ledges of rock, and the cost of excavation fixes a limit to the practicable depth. The matter was ably discussed by the Isthmian Canal Commission and the conclusion was reached that the natural oscillation of 13 feet must be reduced to rather less than 7 feet. The level of the lake must be held approximately between 111 feet and 104 feet above tide, and the bed must be excavated sufficiently to afford a sailing depth of 35 feet at all times. But the records establish that years of high lake and years of low lake follow in no regular succession. As it is impossible to provide a reserve sufficient to control the level of an immense body of water 3,000 square miles in extent, the regulation of this vital element must be left to the foresight and good judgment of the operator controlling the outflow at the dam. The uncertainties under which he would labor are clearly set forth in the report of the Isthmian Canal Commission.

> "The preceding results obviously can not be considered finally conclusive as to what may happen in regulating the lake in the manner desired, for the reason that a larger monthly rainfall than that corresponding to 16.7 inches at Grenada may occur in October of any year, or in any other month following preceding rainy months which have left the ground in a saturated condition. Concurrent rainfall and lake-stage records are not sufficiently extended to afford a demonstrative treatment of this part of the question."

Carelessness, or bad judgment on the part of the operator at the dam, or an abnormal season, might therefore involve the stoppage of traffic

for an indefinite period. A really desirable canal should be subject to no such contingency.

In reference to the technical difficulties of construction little need be said, now that the work is no longer contemplated. Although the dam on the San Juan river has been considered "feasible" by good engineers it is certain that no such construction has ever been executed. To sink a long, continuous, and water-tight row of pneumatic caissons upon the rock bottom, at the extreme practicable depth of operation, below the bed of a river that cannot be diverted, and where the work is liable to be deeply submerged by floods, whether in the San Juan or the San Carlos, is certainly neither an easy nor a safe operation. But the dam is not the only technical conundrum. The deep excavation at the Culebra, on the Panama route, has been so much discussed that the difficulties of similar work in Nicaragua have not attracted the attention that they deserved. The Senate Committee on Interoceanic Canals was informed by one of the members of the Isthmian Canal Commission: "The cut at Tambercito is in hard rock, and while it is deep there is no trouble about that. The conditions are favorable; but at these other two places the conditions are not favorable, and we find that underneath the rock there is a layer of clay. In one place we go through rock twice in our borings and then strike clay in the prism of the canal. That is not an ideal condition of affairs. The Culebra cut is a long one, but the material there is thoroughly understood now." * * "I would rather take the Culebra." Another member laid stress upon difficulties of another character: "I think that swampy country between Greytown and the San Juan River is going to be a very difficult country to work in. It is practically a continuous swamp." * * "It is about 40 miles, practically." * * "It is a swamp throughout. There are no roads in it. You cannot make any roads except by hauling in material to make them. There have never been any, and there is a good deal of timber in that swamp. How much of it is below water I do not know. I do not think we have any idea; but there is, in my mind, a very uncertain element as to how much timber you will find to interfere with your dredges while working in that swamp." * * "A good deal of it is ooze—soft. It is perfectly natural that there should be a swamp in a country of such excessive rainfall."

It should be carefully borne in mind that the language of the law under which the Isthmian Canal Commission was required to act called for information respecting "the most feasible and practicable route" without demanding an opinion as to the absolute merits of the

canal when opened to traffic. The Report nowhere states that a Nicaragua canal completed according to the project would furnish a fully satisfactory transit route, capable of competing on favorable terms with that by Suez. The fact that they estimated the annual cost of operation and maintenance at $1,300,000 more than at Panama sufficiently indicates that they appreciated its inherent defects in rejecting it.

It remains to apply this test of practical utility to our contemplated canal by way of Panama. In the important element of natural harbors the route has met all the requirements of commerce during the four centuries since its discovery. On the Pacific, when the canal reaches deep water, no works of harbor improvement will ever be required. On the Atlantic, the natural depth now meets the needs of ordinary commercial steamers, and when more is required it may be secured by dredging, without fear of deterioration, since there are no moving sands to be combated.

The merits of the inland route are equally conspicuous. The distance is only about 45 miles from ocean to ocean, or only one quarter as long as that by Nicaragua, and the summit level may be fixed at about 65 feet, or a little more than half that at Nicaragua. The route is swept by no strong winds; the curvature is exceptionably favorable as compared with existing ship canals; the annual rainfall ranges from about 140 inches on the Atlantic coast, to about 93 inches in the interior and about 60 near the shores of the Pacific, with a well defined dry season of fully three months; and with judicious regulation of the Chagres river there will never be objectionable currents in any part of the route. The transit from ocean to ocean may be made in a single day without encroaching upon the night, but night passages can be made easy and safe by a system of electric lighting supplied by water power at the two dams on the Chagres. The floods of the river may be readily controlled, and ample provision to meet the low-water requirements of the canal may easily be made. In a word, an excellent canal well suited to the needs of navigation may be constructed; there are no technical difficulties that will not yield to the ordinary resources of modern engineering, if judicious measures are adopted in preparing the final plans. It is true that five locks will be required, two to reach the summit level, two to descend, and one to overcome the large tidal oscillation on the Pacific coast; but experience on the Manchester Ship Canal has demonstrated that they will entail no serious difficulties in navigation. It has been claimed that they may be avoided by constructing a tide-

level canal, but no demonstration has yet been made that the regulation of the Chagres river under these conditions will not introduce features far more objectionable than modern locks.

It may be interesting to refer to the three objections which have been raised by the advocates of the Nicaragua route. These are the greater distance from our Atlantic and Gulf ports to San Francisco; the obstacle to the passage of sailing ships caused by uncertain winds in the Gulf of Panama; and lastly the health question.

As to the first, the objection is apparent rather than real, since the time lost on the longer sea route will be fully compensated by the gain in time required to traverse the canal, to say nothing of the saving in cost due to lower insurance rates, which will probably be only about one fourth as much as by Nicaragua.

Sailing ships would require towage throughout the entire extent of the Nicaragua route, and the same distance at Panama would carry them nearly or quite to a point where winds might be expected. It is true that the winds in the Gulf of Panama are uncertain, but sailing ships have used the route for hundreds of years, finding it to be the best for trans-shipment of their cargoes across the Isthmus.

In the matter of health the route by Panama enjoys an unenviable notoriety, but it must not be forgotten that the record has been largely aggravated by the disturbance of the surface soil in the construction of the railroad and the canal. As the excavations have now passed through this layer, and have reached the much less dangerous soil below, a marked improvement may be expected, especially when the requirements of modern sanitary science are rigidly observed. In fact, the actual experience of the New Panama Canal Company more than justifies this expectation. The medical director of the fine Company hospital near Panama reported in 1902: "Considering the average figures for the last four years, I find that with a personnel of 2,275 the percentage of disease has been 29.65, and the mortality 2.35 per cent. These figures do not exceed those on large works in any country." After our good work accomplished in Havana we may count on an equal success on the Isthmus. The apparent superiority of the conditions in Nicaragua is probably due in no small degree to the absence of population between the lake and the Atlantic coast.

In fine, now that the problem has been thoroughly studied, and that the facts are known, and that fortune has enabled us to secure the better route, we have good reason to rejoice that hasty action was delayed, and that no mistake has been made in the selection.

ORGANIZATION AND PERSONNEL IN THE BUILDING OF THE PANAMA CANAL.

By Fullerton L. Waldo.

Mr. Waldo, through the association of his father, Dr. Leonard Waldo, with Mr. George S. Morison, and his own association with their office, was in close touch with Mr. Morison during his work on the Canal Commission, and in full possession of Mr. Morison's personal and professional views regarding that work. Their spirit and influence are infused into the following article. It is a short and timely outline of the practical aspects of the construction of the Isthmian Canal.

Probably the strongest and most urgent suggestion which follows its reading is that it is vitally important the President should exercise the very utmost of wisdom, judgment, and courage in his appointments to the Commission which will have charge of the construction work. It demands engineering talent, executive capacity, unshakable integrity, and personal force—all of heroic mould. And every influence that can be exerted should rally to support the Administration in seeing that no one who does not fill this type is given a place on the Commission.—THE EDITORS.

IN spite of the 1,163,000 words spoken against it by Senator Morgan, the Panama Canal is now sure to be built. The past and present history of the project of interoceanic communication is a matter of written record, if one knows where to look; statisticians have busied themselves with forecasting the commercial future of the canal in illusory terms of the net tonnage; the present article is restricted to the prospect from the point of view of the human agent who is to do the actual work of digging and keeping open "the big ditch."

Colon, where the canal begins, on the Caribbean side of the Isthmus, is no place for a white man. It is just an assemblage of mean dwellings and buildings for the railroad, having a population of only a few hundred, without drinkable water or eatable food. A member of the Isthmian Canal Commission would have liked to see the place burned up, and rebuilt on higher ground. The whole Isthmian region has been destitute of drainage for four centuries. What has been done at Santiago de Cuba and at Havana must be repeated here. Colon must be either wiped off the map or cleaned up.

We now know how to mitigate, if not utterly abolish, tropical diseases of the commoner sorts—yellow fever, typhoid, dengue, cholera, malaria. The part the mosquito plays as a "peddler" of malaria germs is realized—as Dr. Howard's book bears scientific witness. A course of lectures was delivered before the students of Jefferson Medical College in Philadelphia by Surgeon Charles F. Kieffer, U. S. A., on the

less common types of tropical disease—the various devilish sorts of tropical fevers that gallop a man to his grave; dysentery, abscess of the liver, intestinal parasites, and the rest of the unpleasing category. These lectures are published in the Philadelphia *Medical Journal*, beginning with the issue of January 24, 1903. They are important as being the first systematic instruction with regard to the subject in the United States.

While the earth is turned up to sun and rain along the whole line of the canal works between Colon and Panama is the period when these various diseases will especially get in their deadly work. The Panama Railroad Company tried workingmen of every clime, when the road was being built, and found that the Jamaica negro was the only man who could stand it. "The Chinese rotted," says one engineer, describing his difficulty in getting laborers to build a railway in Costa Rica; "you have to use the Jamaica nigger for that sort of thing." The latter is a "big, black, bounding beggar," sure to go roaring drunk on pay-day. That is one reason why the United States Government must thoroughly police the canal. White men will "boss," and control the highly specialized excavating machinery; but the pick-and-shovel digging is to be done by men whose intelligence is little, if any, removed above that of the brute—and men who are "as lazy as they dare to be."

It is a huge lie that "a life was laid down for every tie of the Panama Railway." Nobody knows just how many Austrians, Irish, Frenchmen, or coolies died, or just how many carloads of "niggers" were dumped out on the flanks of Monkey Hill for superficial burial; but there are more than a hundred thousand ties in the Panama Railway, and there has never been more than a sixth of that number of men at work, even when the Panama Canal Company were conducting the members of the Isthmian Canal Commission on a tour of observation, with a view to making a sale to the United States Government. The old machinery of the French Company is not good for much at present. The American engineers on the whole would rather not have it there. Some of the devices are obsolete; of many, the use has remained undiscovered; probably some of the machinery was built only to sell to the contractors. The United States Government will find it advantageous to install a practically brand-new working plant. Furthermore, the French in their day knew not the possibilities of applied electricity; there is certainly no nation better qualified than the United States to realize these possibilities now in the work of excavation. And the use of electrical power, created by the abundant

water-sources, will diminish the number of skilled white laborers required. There must be a number of new types of machinery invented in this connection. The late lamented George S. Morison says, referring to the *crux* of the whole work, the Culebra cut:—

> "No work has ever been undertaken on which the highest class of practical engineering talent could produce so great economies as in this particular great concentrated excavation. The Isthmian Canal Commission estimated the cost of this excavation at 80 cents per cubic yard; bad management would quickly raise this to a dollar, and it is not impossible that with a carefully considered equipment the cost could be reduced to 60 cents. In this single cut, $25,000,000 is an easy measure of the difference between competent and incompetent management." [*Proceedings of the American Society of Civil Engineers*, January, 1903.]

In building the Bohio dam, to form Lake Bohio, the summit level of the canal, caissons must be sunk to a depth of 128 feet, and here, again, enters the human factor. Pneumatic work has hitherto not been carried on at a depth below the surface exceeding 110 to 115 feet. The additional depth means an atmospheric pressure greater by five or six pounds to the square inch. The unprecedented depth has frightened some engineers from the project. Professor William H. Burr, of the Commission said in a hearing before a Congressional subcommittee [February 21, 1902]:—

> "The depth of 128 feet is greater than has yet been reached by the pneumatic process of constructing foundations, the process ordinarily used in such work; but there are methods of reaching that great depth which are entirely feasible. The physical features of the situation are such at Bohio that I am perfectly confident, from my own experience in engineering work, the foundations of that dam can be put in place without using air pressures higher than those which have been encountered in other works."

The caissons of the new East River Bridge went down to a depth of 115 feet; the depth in the case of the Eads Bridge at St. Louis was about the same. A man cannot work more than an hour at this depth. The avoidance of the necessity for frequent relays in this pneumatic work is one of the problems to be solved by the canal engineers; and here, again, is a chance for American inventive genius to meet the occasion with wholly new devices.

Thirty thousand men, it is said, will be wanted for the actual digging of the canal. But no one can authoritatively say at present just how many men will be needed. Ere the real work of building is reached, two preliminary years must be spent in getting ready exact and accurate engineering specifications, in providing a supply of drinking water along the route—a huge and all-important, but perfectly feasi-

ble, undertaking—in arranging to enforce police and military regulations, in developing the existent excellent hospital system, and in the works of sanitative engineering at the termini and along the entire canal strip. After all this has been done, it is supposed the Panama Canal will take eight years to build.

The plan of the Isthmian-Canal Commission for the maintenance and operation of the finished canal, which was not published in their official Report, but which was later introduced at a hearing before a sub-committee of the Senate Committee on Interoceanic Canals, is of interest and significance, now that the fulfilment of the project is assured. While undoubtedly there will be substantial modifications, the estimate expresses the carefully considered conclusions and shrewd judgment of the men who are best qualified to know.

By this plan, the general control is vested in a governor, at Colon. Lately, the foolish saying has been current, and has gained credence, that this governor is "a doomed man." If the United States intended to accept sanitary conditions on the Isthmus as it finds them, the $15,000 salary it is proposed to pay might hardly tempt a capable man to undertake the governorship. But the United States is going to "change all that"; and to our own perfervid imagination a new Ponce de Leon or Alcazar at Colon is one day not impossible.

The Governor will be responsible to a supreme board of five at Washington, who, by the Commission's plan, will have $100,000 a year to spend, and are therefore certain to be pilloried by western congressmen.

Subordinate to the governor's office are six departments—of engineering, transit, medicine, finance, law, and police respectively. The engineer's department will employ a chief engineer at $7,500 per annum; an assistant engineer at $3,000; a chief clerk at $2,000; two draftsmen at $1,500; a clerk at $1,500; a stenographer at $1,500; a messenger at $400; one master mechanic at $3,000; two foremen mechanics at $2,000; ten mechanics at $1,500; ten helpers at $360; one clerk at $1,200; a master laborer at $900, five laborers at $360. Subsidiary shops, general storehouses, and locks will employ about one hundred other individuals, at salaries ranging from $2,400 for the chief storekeeper and for the overseer of the locks, down to $360 for day laborers.

The transit department will have a general superintendent with a salary of $7,500. An assistant superintendent will receive $3,000; there will be also a chief clerk at $2,000, two clerks at $1,500, a stenographer at $1,500; two clerks at $1,200; a surveyor at $1,800; a

captain of the port at $2,400; a chief telegrapher at $1,800; a messenger at $400. The superintendent of the Panama Railroad is to be an official of this department, and the sum of $45,000 per annum is set aside for the maintenance of the railroad with a working force not specified, the receipts being relied upon to cover the actual transportation expenses. The captain of the port is to have under him twenty pilots, at $2,000 each, two light keepers at $900, and four sailors to look out for buoys of the channel. This force, with the exception of those connected with the railway, is stationed at Colon. There are under the chief telegrapher eight linesmen at $720 and fourteen operators at $900. At Panama there are also a port captain, a surveyor, two light keepers, two clerks, and four sailors. The pilots are included in the enumeration for Colon. At each of the three locks will be stationed a lock master, at $1,800, an assistant lock-master at $1,200, and twenty-seven others—machinists, foremen, gatemen, linemen, watchmen.

The chief surgeon, in the medical department, is to have a salary of $6,000. The importance of his office cannot be over-estimated. There will be a chief medical inspector, at $3,000, two clerks, and a messenger attached to his staff. It will be necessary to have a quarantine officer at each terminus, at $2,400. Three hospitals, at Colon, Bohio, and Pedro Miguel, will each be provided with a corps of nine nurses and others under an assistant surgeon at $2,000. The general hospital at Panama will require the services of five surgeons, two stewards, twenty nurses, four cooks, ten laborers. The chief surgeon receives $3,600, and the assistant surgeons $2,000.

In the finance department, the treasurer will receive $6,000. He will have under him two collectors at $2,400, and eleven other subordinates at salaries from $2,400 down to $400, the sum which the two messengers receive.

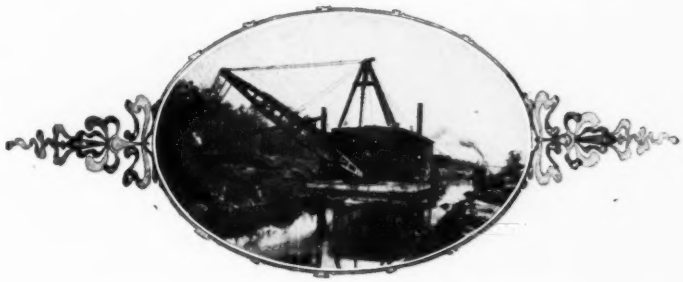
The head of the law department is the solicitor, whose salary is $6,000. To his office are attached three clerks and a messenger. There will be a justice of the peace at Panama as well as at Colon; these officials may be men connected with the canal in other capacities; they are to receive $500 additional pay.

The police department is directly governed by a marshal, at $6,000. To his office are allotted a clerk and a messenger. At each canal terminus is a post comprising a captain at $2,000, two lieutenants at $1,500, twelve sergeants at $1,200, ninety privates at $1,030. For the use of this department, twenty saddle horses are kept, at $250 each, at each post.

It is seen, therefore, that the maintenance of the canal according to the official estimate will enlist the services of at least six hundred and forty-five persons, exclusive of the management of the railway. The complete cost of annual maintenance is about $2,000,000.

It should be remembered that the efficiency of the workingman from the North is decreased by about one-half in the tropical climate. The numbers of workmen needed may easily, therefore, be far in excess of the figures given. It is impossible at a desk many hundreds of miles away to forecast contingencies at the seat of actual operations. But one thing is certain—the Panama Canal can be built and maintained without jeopardizing the health of Americans who are among the toilers in the field. And finally, let me quote Mr. Morison's words in the *Bulletin of the American Geographical Society*, February, 1903.

> "When the canal is built, the malarial spots in the interior will have been replaced by Lake Bohio, and the condition of the Isthmus should be no worse than that of other damp tropical countries. Lake Bohio, surrounded by hills and mountains, will be a beautiful and accessible body of water, traversed by frequent steamers, with all convenient connections with the ports of other countries. The surrounding hills will add beauty to the landscape and furnish sites for gardens and residences. It is not impossible that this region, which has been regarded as one of the world's pestholes, will in time become a favorite winter resort."



THE MARIENFELDE-ZOSSEN HIGH-SPEED ELECTRIC-RAILWAY TRIALS.

By Dr. Alfred Gradenwitz.

The following account of the Marienfelde-Zossen high-speed trials will be of interest in connection with the successful results recently obtained, which aroused a sensation all over the world.—THE EDITORS.

THE Marienfelde-Zossen high-speed electric-railway trials, as is known, were undertaken with a view to obtaining the necessary technical and economical data for a regular electric-railway service up to speeds as high as 200 kilometres per hour. Useful data were available from previous trials made by the Siemens & Halske Company on their special experimental line in Gross-Lichterfelde near Berlin, which line was intended to be a model railway for operation by 10,000-volt currents. It is due mainly to the enterprise of the two leading electric firms in Germany, the Siemens & Halske Company and the Allgemeine Elektrizitäts Gesellschaft,* as well as to the assistance of the most important German banking firms and the authorities concerned, that as early as the fall of 1899 a special concern was formed under the name "Studiengesellschaft für Elektrische Schnellbahnen." The German railway authorities placed at the disposal of the undertaking the Marienfelde-Zossen military railway, and two cars to be constructed respectively by the firms mentioned above were to be used for the experiments.

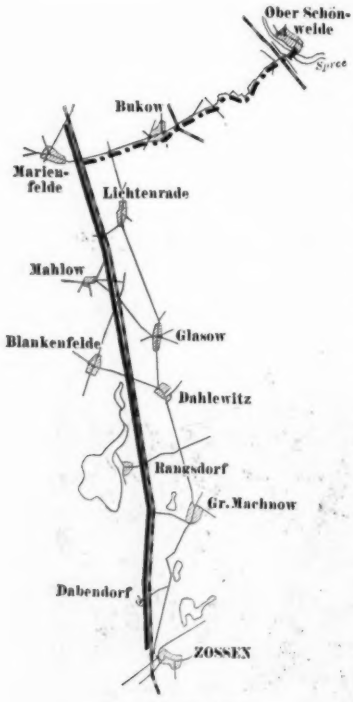
The Siemens & Halske Company undertook the construction of the line supplying the electric power, whereas the A. E. G. were willing to generate the power in their Oberschönweide electricity works as well as to construct the feeding wires thence to Marienfelde-Zossen. The line was to be constructed after the model of the Gross-Lichterfelde experimental track, and the same arrangement of the conductors and collectors, as well as the same kind of current, namely 10,000 volts rotary current between two conductors, was to be used.

The Marienfelde-Zossen military line, 23 kilometres in length, seemed specially available, as there are no curves of less than 2,000 metres radius the short gradients being not more than 1:200. The permanent way, however, corresponded only with the older types of

* Familiarly known by the convenient abbreviation "A. E. G.," which is frequently used in this article.

THE MARIENFELDE-ZOSSEN TRACK.

Prussian railways, consisting of light rails of 33.4 kilogrammes per metre (67 pounds per yard), placed partly on wooden sleepers and partly on short iron sleepers, the road bed consisting mainly of inferior material. Though it accordingly was anticipated at the very outset that the existing permanent way would not be sufficiently resistant for maximum speeds as high as 200 kilometres per hour, it was decided to begin the trials without any rebuilding of the track, apart from some immaterial improvements. After the number of sleepers had been somewhat increased, and the road bed re-enforced with consider-

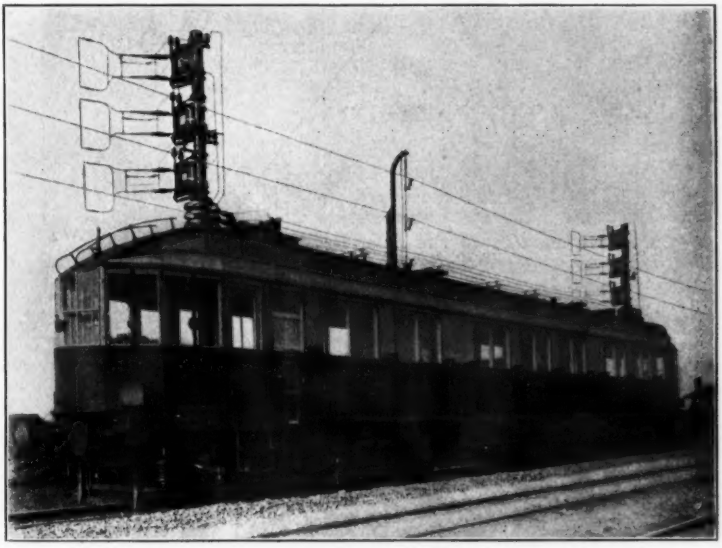


MAP OF THE LINE.

able amounts of broken stone, the track stood perfectly well the strain involved by speeds up to 130 kilometres (80.8 miles) per hour. As, however, in connection with the experiments made in the fall of 1901, serious troubles were experienced for the maximum speeds of 140 to 160 kilometres per hour, a thorough rebuilding of the track was eventually carried out in the course of the summer of 1902. The new rails have a weight of 42 kilogrammes per metre (about 84½ pounds per yard) and a length of 12 metres, being placed on 18 fir sleepers with hard wood pegs; 15,000 cubic metres broken basalt were used for the road bed. About 17 kilometres of the track were fitted with guard rails such as used in connection with ordinary railways on bridges, etc. These guard rails, the foot of which is 50 millimetres distant from the main rail, are fixed on cast-iron beds screwed to every sleeper, this arrangement, in addition to preventing derailments, imparting an extraordinary strength to the whole of the road bed.

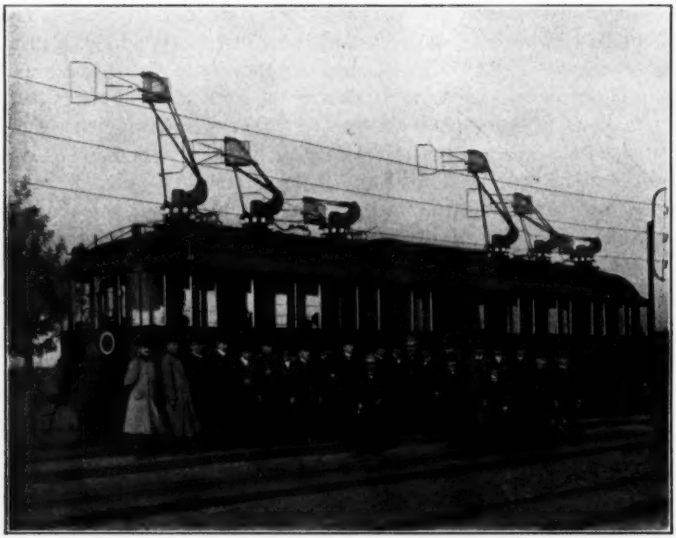
The Overhead Line.—The arrangement of the overhead line is shown by the accompanying figures, the middle of the pole being about 2¼ metres distant from the middle of the track and the three horizontal wires conducting the three-phase current being about 1 metre apart. The picture opposite shows the construction. The whole of the line is divided into sections of about 1 kilometre, each of which is provided in the middle with a device for compensating losses in pressure. The neutral point of the system is connected to the earth and to the rails. The suspension point moves aside somewhat as the collector presses against the horizontal wire, a satisfactory and simultaneous contact between the three horizontal wires and the contact arcs being thus possible. This is ensured by having the single parts on the out-

rigger, intended for carrying the insulators, connected by joints. The horizontal wires have a double insulation against earth, and each insulation separately is susceptible of standing the whole of the maximum pressure of 20,000 volts occurring during the service. The wires have cross sections of 100 square millimetres (0.155 square inch) each, the tension between each two wires varying between 10,000 and 12,000 volts. Hard copper wire with a breaking strength as high as 38 kilogrammes per square millimetre and a conductivity more than 97 per cent. of that of chemically pure copper is used; lightning arresters are provided, as well as safety devices in case of a fracture by which the wire is automatically earthed.



THE SIEMENS & HALSKE CAR USED IN THE MARIENFELDE-ZOSSEN EXPERIMENTS.

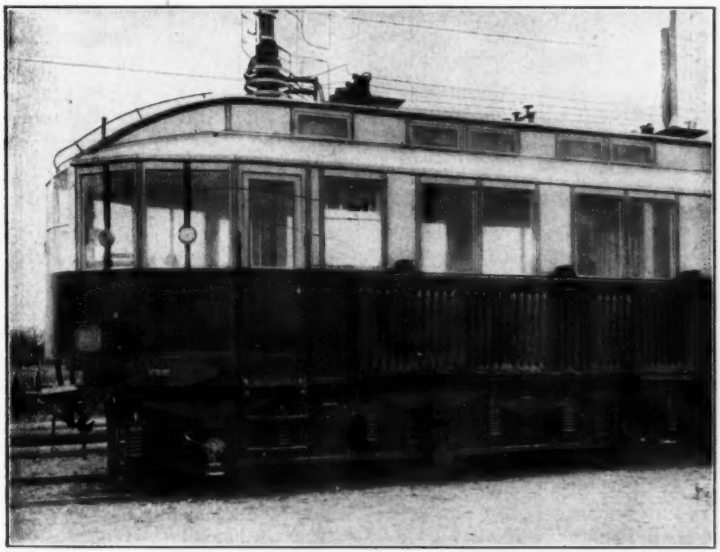
The Collectors.—The collectors are constructed according to the system developed by the Siemens & Halske Company on their Gross-Lichterfelde experimental track; they are nearly identical on both cars, differing only as to the details. In the Siemens' car they have the form of two masts supported by the cars at either end and movable around their vertical axis. These masts consist of two Mannesmann tubes, each about 200 millimetres in diameter, inserted one into the other. By means of a crank acting on a double toothed gearing, any desired rotation of the masts may be effected from the motor-man's



THE A. E. G. CAR USED IN THE MARIENFELDE-ZOSSEN HIGH-SPEED RUNS.
View taken immediately after the successful trials on Oct. 28, when a speed of 210 kilometres (130.5 miles) an hour was attained.

stand. The sliding rings are attached to an insulated tube. Contact springs, screwed by means of hard rubber insulators on a special flat iron frame, are fixed to the three sliding rings. Into the insulating tubes and partly into the lower part of the collector, the upper tube is slipped, so as to be readily dismounted after loosening a few screws. This tube bears, at central distances of 1 metre each, three rotating axles for the contact bows proper. The wind pressure against the bow on one side of the rotating axle is balanced by means of a vane attached to the other side of the axle. The A. E. G. car is likewise fitted with two groups of three collectors each, one for each phase, which however, instead of being placed on one common mast, are arranged one behind the other. Both arrangements have so far given full satisfaction, it being impossible to decide which is the more available. Sparking between the overhead wires and the collector bows, as occasionally noted in connection with the earlier experiments, was recently prevented by some slight improvements in the construction of the collectors. One of the most difficult problems, namely the transmission of high amounts of energy from a stationary conductor to a train running at enormous speeds, has thus been satisfactorily solved.

The Motor Cars.—The two motor cars used with these trials were constructed by Messrs. van der Zypen & Charlier, Cologne-Deutz, in accordance with the electric apparatus supplied by the two electric firms. The cars, intended for about fifty passengers, are 21 and 22 metres in length respectively, and correspond as to their dimensions and equipment with the technical regulations of the Association of German Railway Administrations. The body of the car rests by means of two centre bolts on two trucks without any special springs. In addition there are on the frames of each truck four steps limiting the lateral oscillation of the body by bearing part of the weight of the car. Lateral oscillations of the body were moreover observed only for lower speeds, up to 100 kilometres per hour, whereas with higher speeds the run of the cars was perfectly steady, much more so than with ordinary rapid trains. Each of the trucks is fitted with three axles, the external axles bearing the motor, whereas the central ones serve as running axles. The distance between the axles was at the beginning 3.8 metres; this has been increased up to 5 metres in connection with the recent successful trials. The distance between the centres of each two trucks is 13.3 and 14.3 metres respectively, and the diameter of the wheel tread 1.25 metre. Two springs are placed against the axle



THE TRUCK; IDENTICAL ON BOTH CARS.

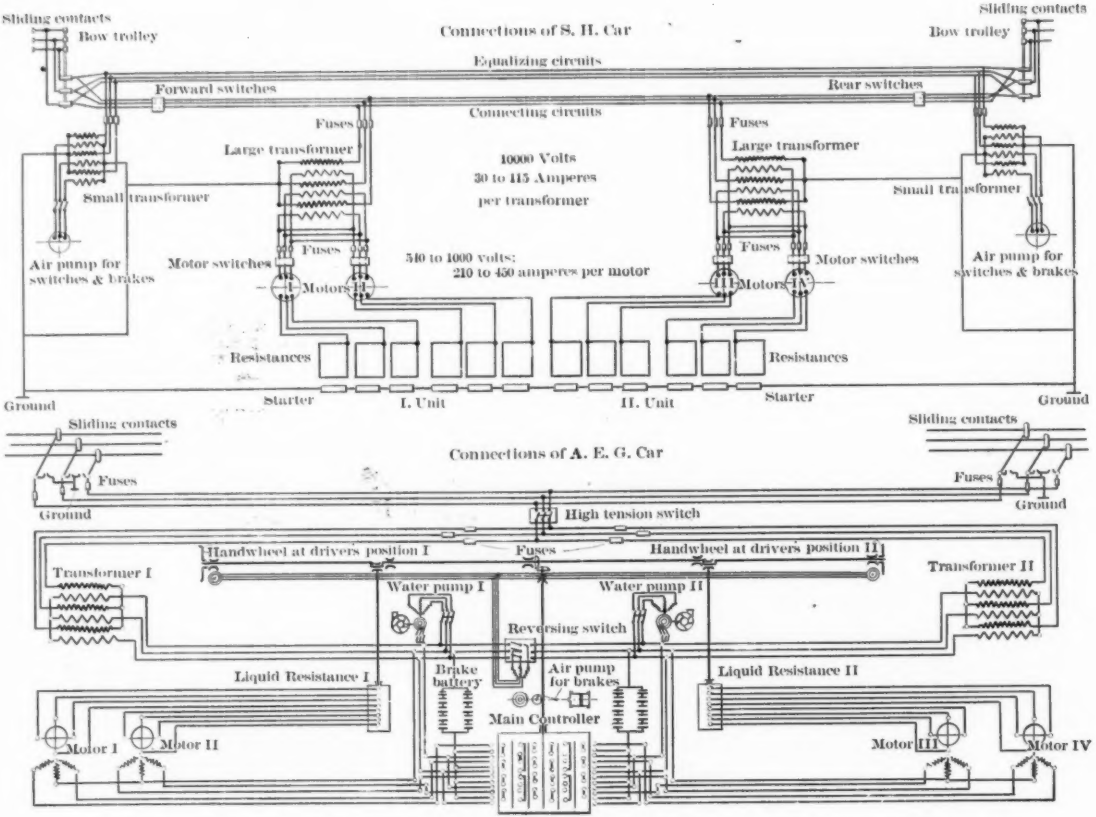


DIAGRAM SHOWING THE CONNECTIONS OF THE SIEMENS & HALSKE AND THE A. E. G. CARS RESPECTIVELY.

boxes, namely one plate spring, 1.5 metre in length above each axle box, these plate springs being in turn maintained at their ends by spiral springs, the tension of which is regulated by means of screws. As the trucks, in connection with the earlier experiments, followed any deviation in the direction of the track, the distance of the wheels as above said was increased to 5 metres and the bearing springs placed so as to be visible and connected with one another by compensating levers. The centre bolts, which formerly were rigidly fixed to the lower frame, were in the course of the recent reconstruction provided with lateral pegs fitted with springs, so as to prevent any transmission of the oscillations of the body to the frame.

The Connections of the Cars.—The connections of the cars are shown on page 500. In the A. E. G. car, the current is led by means of armoured cables from the two groups of collectors to the main switch in the machine room and thence by separate conductors to the transformers. The main cut-out switch is operated only after the run is completed, or as an emergency switch in case of disturbances occurring during the run. From the transformers the low-tension conductors lead through the main controller to the motors. The main controller is also placed in the machine room of the car, being easily actuated from each driver's stand through a steering wheel connected by toothed gearing to an axle traversing the whole length of the car. This controller directs the working current to the motors and through the resistances, and permits forward and reverse running, besides providing for the braking of the car by means of reverse current. There is in addition a small controller in the driver's stand, conveying low-tension current from the transformer to the motor for operating the air compressor in connection with the compressed-air brake.

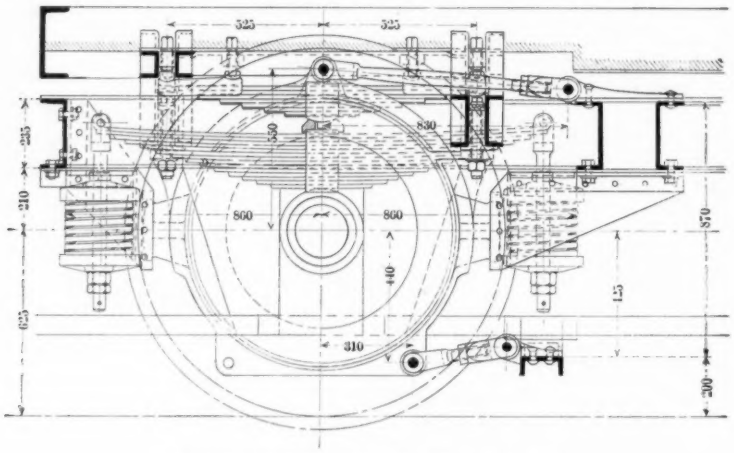
The connections in the Siemens & Halske car are somewhat different, the high-tension current being first conveyed to one of the two main switches for forward and backward running, which may be controlled from the driver's stand, and thence to the two large transformers, whence the working current is again conveyed through individual switches towards the motors and the resistances. From the main conductors on the roof of the car, part of the current is in addition branched off towards the small transformer placed above the motor'man's stand, and conveyed to the electric motor operating the two air pumps. Two special cranks are provided in the motor-man's stand for actuating the reversing switch and the motor switch respectively, the working resistances being controlled by the driver through a special controlling wheel with or without the agency of

compressed air. These equipments have given satisfactory results with both carriages and proved very effective, affording full protection against the electric current.

Transformers.—The main characteristics of the transformers used in each of the cars are as follows:

In the transformers of the Siemens & Halske car the effective iron sheets are placed vertically on their small edges and distributed in groups, between which there is space for the passage of air. The secondary coil is well insulated from the iron cores, the coils of the primary winding being placed above it. In the ventilating channel of the iron cores, there are protective boxes prolonged as far as the front plates of the casing and expanding into the latter so as to facilitate the drawing in of the air.

The transformers in the A. E. G. car are designed according to the patents of this company with three parallel iron cores, the axes of which run longitudinally. Each iron core is provided with a longitudinal slot through which, as well as between the rectangular cores



SUSPENSION OF THE MOTOR ON THE A. E. G. CAR.

and the round coil, an air current is allowed to pass. The transformers in both cars have given full satisfaction, the strong air currents proving particularly effective and preventing any considerable heating effects.

The Motors.—The motors of the A. E. G. car are designed for an output of 250 horse-power each, provided with fork-bar coils; the

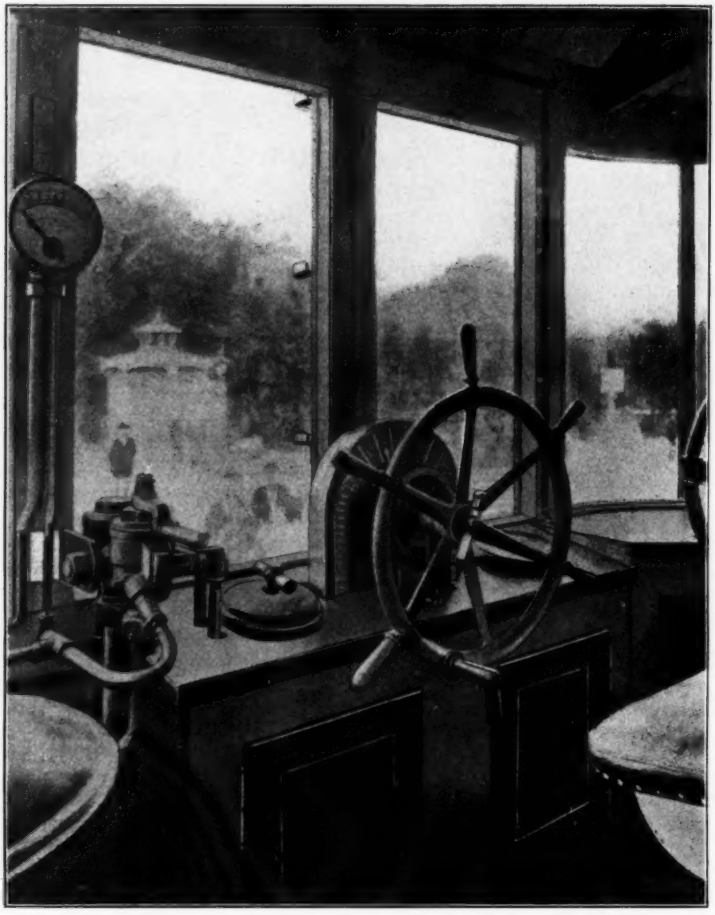
exciting current has a tension of 435 volts. The motor cases are fixed on an iron frame supported on both sides of the carriage by plate springs, each of which is fixed on the main bearing spring of the car. The motor casings each bear a hollow axle, slipped over the car axle, on which the armature of the motor is built. The motor is coupled to the wheels of the corresponding axle by means of double arms attached on both ends of the hollow axle and touching the sliding pieces placed on the wheels. The weight of the motor, instead of resting immediately on the axles of the car, is thus supported by bearing springs on the axle boxes of the truck.

The motors constructed by the Siemens & Halske Company on the other hand are six-pole motors, also for outputs of 250 horse-power each, the energy current being conveyed to the rotor at a tension of 1,150 volts by means of three sliding rings. The pressure in the secondary circuit at rest and at first starting is 650 volts. The rotor is provided with closed direct-current bar windings, whereas the stationary part of the motor has rotary-current bar windings. The rotor with its box is pressed strongly on the axle of the car. The stationary part of the motor, enclosed by a double cast-iron casing, rests without any intermediate spring on the car-axle bearings. The diameter of the rotor is 780 millimetres, whereas the external diameter of the motor is 1050 millimetres.

Both the direct fixing of the motors on the axles and the suspension by springs on the truck have given full satisfaction in connection with the experiments so far made. In general, the spring suspension seems to be preferable to the rigid suspension of the motor.

Exciters and Resistances.—The exciters and resistances, necessary in starting and in controlling the speed, show also some essential differences in the two carriages. In order to avoid any abrupt variations in the speed and any excessive sparking in the car, the resistances must be switched off from the circuit quite gradually. In the A. E. G. car there are to this effect liquid resistances of the following construction:

The terminal plates of the opened circuits are placed in two reservoirs in the central machine room of the car. Beside each of the reservoirs there is an electrically-driven centrifugal pump, conveying into the upper reservoir a soda solution placed in a box below the carriage. The higher the liquid in the latter, the smaller will be the resistance between the electrodes; the height of the liquid is regulated from the driver's cab by means of a valve. The pumps work permanently during the run, the liquid circulating in a tube conduit ensuring a permanent cooling (refrigeration). This exciter affords the ad-



THE MOTOR-MAN'S STAND IN THE A. E. G. CAR.

vantage of dispensing with the contacts and cable joints necessary in connection with solid exciters.

In the Siemens & Halske car, on the other hand, there are metallic resistances, formed of "Kruppine" bands 45 by 2 millimetres in section. These bands are placed by groups in flat boxes fitted outside on the longitudinal wall of the car below the window. There are in all twenty-nine steps, four being intended for the first inserting and

twenty-five for increasing and regulating of the speed of the motors. Below the resistance boxes there are the exciter rollers placed longitudinally and bearing bronze contact pieces; the corresponding contacts are attached to two steel tubes placed one beside the other, and isolated from them. In order to avoid any such disturbances as would attend on an abrupt increase in collecting the current, the single contacts are inserted not simultaneously but successively. The exciting rollers are actuated through a longitudinal spindle traversing the whole of the car, rotated from the driver's stand by means of a conical toothed gearing. In order to facilitate the handling of this controlling device, there is a compressed-air apparatus assisting the driver in starting and reducing automatically the exciter to its zero position if the current has to be switched off. By means of a special gearing, the controlling may be effected also without the aid of compressed air.

The Trials.—In connection with the trials made in the course of the fall of 1901, speeds as high as 150 kilometres, and even in one case 160 kilometres, were obtained. As however rather material oscillations and shocks were experienced even at speeds of 140 kilometres per hour, no further increase of the speed was thought advisable for the moment, the remainder of the year being given up to very valuable measurements and records on the consumption of electric energy. The acceleration obtained after starting was different according to the strain the source of power was put to and the performance of the motors. In order to attain speeds of 100 kilometres, starting distances of 2,000 to 3,200 metres, and starting times ranging between 138 and 220 seconds were necessary, these figures corresponding with a mean acceleration as high as 0.13 to 0.20 metres per second. As however the motors are capable of supplying for short intervals about 3,000 horse-power, whereas for the above acceleration only 700 to 1,000 horse-power are required, this represents by no means an upper limit.

As regards the braking of the cars, both cars may be stopped either by means of Westinghouse rapid brakes, hand brakes, or using back current; the A. E. G. car is in addition fitted with an electric brake. The Westinghouse and electric brakes may be operated from each motor man's stand simultaneously, though the braking equipments are independent for either of the trucks. In the case of an air pressure as high as 6 atmospheres in the braking cylinder, two of which are placed on each truck, the pressure on each of the twenty-four braking shoes arranged on both sides of the wheel is about 6,000 kilogrammes, the braking shoes thus receiving a total pressure as high as 144,000 kilogrammes, 156 per cent. of the weight of the carriage.

In connection with the numerous braking experiments performed, the main point was an accurate observation of the air pressure in the conduits and braking cylinders as well as the ascertaining of the braking time and braking distance. On the basis of the braking curves obtained with these experiments, the braking coefficients may be calculated from the equation

$$fD + W + gMa = p\,(M + R)$$

where f is the friction coefficient

D the total pressure on the braking shoes,

M the mass of the car,

R the rotating mass with regard to the periphery of the wheels,

W the air and proper resistance of the car,

a the gradient of the track,

p the retardation in metres per second.

The following figures are given in the report of the experiments:

for $v = 20$, $p = 1.7$ and $f = 1.7$

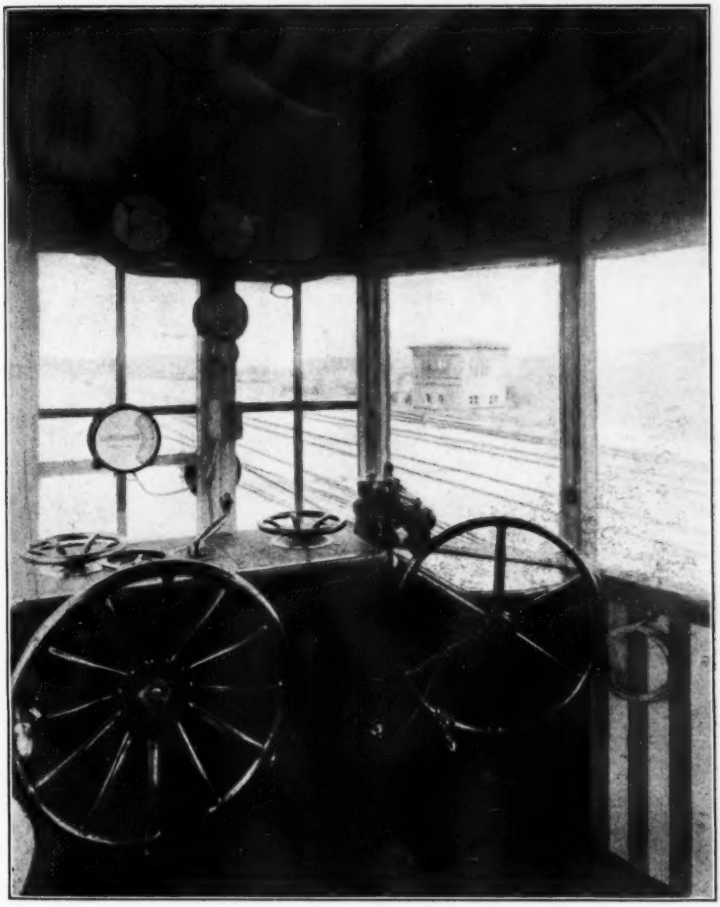
for $v = 60$, $p = 0.75$ and $f = 0.064$

for $v = 100$ $p = 0.6$ and $f = 0.042$

The braking experiments by means of back current as made on the A. E. G. car did not give in the beginning very satisfactory results. As however, back current is likely to act better in the case of higher speeds, the report of the recent experiments will, no doubt, give more satisfactory figures in this respect, though this method of braking is intended to be an emergency braking only.

As regards the resistance of the carriages, the mean value of 3.6 kilogrammes per ton, as obtained for a speed of about 110 kilometres, is materially below the figures calculated from the usual resistance formulae.

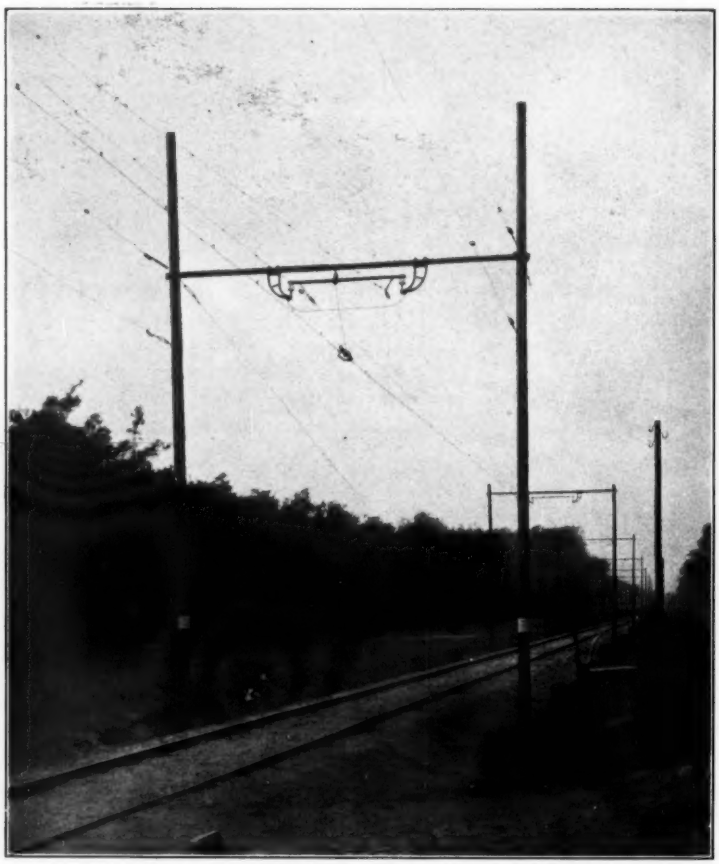
Extensive experiments were made to determine the consumption of energy, both in the electricity works, where records were taken at intervals of 10 seconds, and in the cars, where the tension and current intensities were measured only at intervals of from 15 to 30 seconds. In starting the cars with accelerations ranging between 0.1 and 0.2 metres per second, the consumption of energy in the car on the collectors ranged between 400 kilowatts (544 horse-power) and 740 kilowatts (1,000 horse-power). In the case of prolonged runs, however, the consumption of energy varied between 148 kilowatts corresponding with 90 kilometres, and 520 kilowatts corresponding with a speed of 140 kilometres. It may be stated in this connection that 2,300 kilowatts (2,600 horse-power) have been necessary to obtain the maximum speeds of upwards of 200 kilometres recently attained.



MOTOR-MAN'S STAND IN THE SIEMENS & HALSKE CAR.

When comparing the readings, the great fall in tension will strike the attention in the first place, this fall being due to the fact that the feeding line, 13 kilometres in length, from the electricity works to the military railway, was made up of three copper wires only 50 square millimetres in section.

The air resistance was also carefully studied, recent experiments having given values as high as 210 kilogrammes per square metre for the air pressure.



THE NIEDERSCHÖNWEIDE-SPINDLERSFELDE TRACK AND DOUBLE AERIAL SUSPENSION USED IN THE UNION ELEKTRIZITÄTS GESELLSCHAFT.
The scene of a series of independent experiments.

After the trials made in the course of 1901, a thorough rebuilding of the track, as above stated, was found necessary. This occupied part of the year 1902, the remainder of which was taken up in the continuation of the experiments on the consumption of energy etc. for speeds up to 130 kilometres. The results of the improvements made last year were shown, in connection with the recent trials, to be most satisfactory and even surprising. The track not only stood easily the strain to which it was put by trials at ever increasing speeds, but

the cars would now run with such safety and steadiness as to make the shocks of the rails nearly unnoticeable.

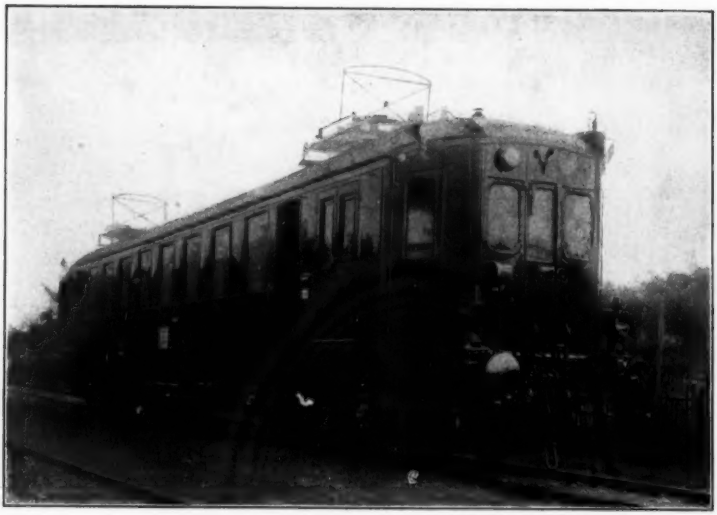
The Siemens' car was first given a chance to show its possibilities; after reaching speeds as high as 189 kilometres per hour at the end of September last, it was anticipated that resuming the experiments at the beginning of October would lead to the maximum speed of 200 kilometres being finally reached. This was actually the case on October 6, the event being watched by a great number of lookers-on. The distance between Marienfelde and Zossen was repeatedly traversed in not more than eight minutes each way, including starting and braking, the maximum speed of 201 kilometres (126 miles) being actually reached on the section Mahlow-Dahlwitz-Rangsdorff traversed in 1½ minutes, throughout about 5 kilometres. The mean speed of 175 kilometres per hour would enable the journey between Berlin and Cologne (577 kilometres) to be completed in about 3¼ hours, whereas the fastest present trains require fully 9 hours.

This result, which aroused such sensation in the engineering world, was exceeded on October 23 when 207 kilometres were reached without any disturbing factors being noted.

The A. E. G. car had meanwhile in turn resumed the experiments, both cars being alternately used in the course of October. In order to ascertain first the working conditions of the car, moderate speeds were used at the beginning, which however could rapidly be increased so that the high-speed car of the A. E. G. on October 28 even slightly exceeded the record made by the Siemens car, reaching the enormous speed of 210 kilometres per hour. Both cars ran so steadily that all those present were highly satisfied.

From a car running at such exceedingly high speeds, neighbouring objects, of course, will disappear from view. Though the motor man would be able to distinguish obstacles on the track, this would be of little use, the braking distance, i. e., the distance from the beginning of braking to the stopping of the train, being 2 kilometres, and 1,600 horse-power having been necessary to obtain the desired speed. Lookers-on could just distinguish the presence of men in the car; before, however, they were able to fix their figure, the car had disappeared from view. Though the track is very straight, there elapsed at most ½ minute between the first appearing of the train and its passage and thence to the instant of its disappearance on the horizon.

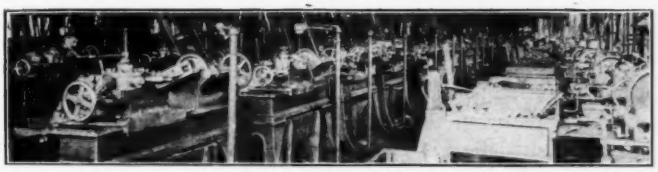
As the maximum authorized speed has now been reached, it is not intended, for the moment being, to drive the speeds up to any higher figures, but to complete the measurements already made by an



NORMAL RAILWAY CARRIAGE USED IN TRACTION EXPERIMENTS, NOW BEING MADE BY THE UNION ELEKTRIZITÄTS GESELLSCHAFT.

extensive series of records, so as to ascertain fully the working condition of high-speed electric railways. It is thought probable that under existing conditions speeds as high as 230 to 240 kilometres per hour may be obtained without any difficulty, but as no authorisation is obtained for the moment, this will have to wait for next year. It is thought probable that after the successful results of these trials some railway will be equipped according to the principles ascertained on the military railway, so as to allow of these interesting trials being continued on a larger scale.

In concluding, I wish to give my best thanks to the Manager of the Studiengesellschaft, Regierungsbaumeister Denninghoff, as well as to Dr. Hamburger and Dr. Reichel, chief engineers to the A. E. G. and Siemens Co. respectively, for kindly supplying the data given in this article, and the illustrations here reproduced.



AN EXAMPLE OF THE MODERN DEVELOPMENT OF THE APPRENTICESHIP SYSTEM.

By L. D. Burlingame.

Mr. Burlingame's topic is one of the most important in the practical conduct of modern engineering industries—the provision for the future "rank and file" of the trade. It was treated from a slightly different viewpoint in Mr. Downton's account of the Westinghouse system in our preceding number. We shall follow shortly with some further examples drawn from other progressive and successful shops, and with discussion of the general problem by some of the best informed and most practical thinkers in the world of engineering manufacture.—THE EDITORS.

WE often hear the complaint that the old form of apprenticeship is dead, and that because it is dead the supply of efficient machinists is dying out. By the "old apprenticeship system" is meant that system by which a boy was indentured at about fourteen years of age to a master, who took him into his family to teach him the trade, the apprenticeship lasting until the boy became of age. That such a form of apprenticeship is almost obsolete follows as a matter of course from the changed conditions of manufacture. A trace of the old method still exists, however.

Near my suburban home there is a "village blacksmith" who still takes apprentices in something of the old way. As this blacksmith keeps horses and a small herd of cows, and in addition cultivates a good-sized garden, it can be easily understood what are many of the duties of his apprentice. The boy learns at least what long hours and hard work are. No doubt his experience is nearer to that of

many of the old-time apprentices than we are led to think by those who bewail the old system's passing away.

The transition period followed when in small shops, often dirty and cold—shops employing but a few machinists and not more than two or three apprentices—the duties of the "cub" were to open up the shop, light the fires, run errands, sweep the floor, and wipe up and oil the machinery. Interesting accounts of these early experiences have appeared from the pens of such writers as "Chordal," W. S. Rogers, and others. Many of the tedious and routine operations now performed by automatic machinery were then done by hand, and the apprentice boys were the natural victims. That the apprenticeship of those days had *some* advantages cannot be denied; it at least cultivated ingenuity in doing without proper tools and produced a generation of good mechanics.

There is at the present time a general belief that nothing adequate has taken the place of these old systems just described. Such a belief has been so often expressed in educational and mechanical circles that those not informed take it as a matter of course that the apprenticeship system is dead. This belief prevails in spite of the fact that there exists in the United States a well established and growing system of apprenticeship, adapted to modern needs. Investigations have been made from time to time to learn the facts regarding the employment of apprentices. One was made by the editor of the *American Machinist* in 1896, when answers were received from more than one hundred of the leading builders of machine tools, engines, and electrical machinery in the country. While a difference of opinion was expressed, a large majority employed apprentices. In about one-half of these shops they were indentured by a regular written agreement. A similar investigation was made last year by Mr. E. H. Parks, for *Cassier's Magazine,* with like results. A good illustration of the development, in recent years, of a well organized and comprehensive apprenticeship system is shown in that of the Westinghouse Company as described in this magazine last month by Mr. Downton. These are some, among many proofs going to show that we have a live apprenticeship system in existence today among our machinery manufacturers. Often those that are loudest in their cry that the apprenticeship system is dead, and that there are no good workmen, are the very ones who do nothing themselves to remedy the difficulty and keep up the supply.

The Brown & Sharpe System.—At the works of the Brown & Sharpe Manufacturing Company the taking of apprentices has been

a part of the established system of conducting the business for a period of time extending over more than half a century. The late Mr. Lucien Sharpe was himself indentured to Joseph R. Brown, who then conducted the business, and served an apprenticeship of nearly five years. Since that time it has been the constant policy of the company to take apprentices and they have proved an important factor in the development of the business. Mr. Sharpe was always strong in his advocacy of such a system. Near the end of his life he expressed the opinion that in the development of his business, nothing could have taken the place of the apprenticeship system, a system under which the boy was indentured for a term of years, by a well defined form of agreement, and an interest taken in him to see that he faithfully fulfilled such an agreement. He pointed out that many of the most important positions in the management of the shop had been filled from the ranks of the apprentices. At the present time over forty such positions within the works are held by those that have served an apprenticeship with the company. A long list of names was recently shown me of some of the past apprentices now holding positions of responsibility in other concerns. The apprenticeship system is not merely a detail, incident to the conducting of this business, but one of the very cornerstones on which its prosperity and permanence rest.

Some Details of the System.—Boys are not accepted as apprentices unless they have an education equivalent to having completed a grammar-school course. It is required that they be physically sound and of good moral character. No boy is employed who is addicted to the use of cigarettes, as it is found that such boys deteriorate as workmen; they are not allowed to use tobacco in the works. A few years ago the term of apprenticeship was lengthened from three to four years, it being considered that more time was needed to train a boy properly as a machinist. It is not expected that even in this time he can become expert, as a specialist, in any branch of the machinist's trade. He can simply lay a general foundation for future development.

The service of apprenticeship is usually commenced between the ages of 16 and 18. The first eight weeks are on trial, after which, if mutually satisfactory, an agreement is entered into for the full term, the pay ranging from 6 cents per hour the first year to 14 cents the fourth year. The boys are given some job work, so rated as to allow them to earn more than their regular wages. This encourages them to put forth their best efforts and aids in bringing their work up to a

commercial basis as regards time. A payment of $50 to the company is required from the boy at the beginning of the term of apprenticeship, for the privilege of learning the trade, and as a pledge that he will fulfill his agreement. At the end of the term, in consideration of faithful service, the sum of $150 is paid to the boy.

When a boy begins work a set of tools is loaned to him. If he is accepted at the end of the term of trial, these tools are sold to him and his name stamped on each.

The time in the shop is so divided as to give experience in lathe work, drilling, milling, assembling and erecting, screw cutting, scraping, planing, and on general work. Those making exceptional progress often occupy the positions of sub-foremen before the expiration of their term of apprenticeship. There are now more than one hundred and forty apprentices in the different departments of the works, including twenty-four in the foundry, three in the pattern shop, and eight in the drafting department.

A society has been organized among the apprentices. They hold meetings every two weeks, listening to lectures upon subjects pertaining to the business. The company allows this time from working hours and often furnishes the speakers from among those in their employ who can speak from experience on subjects connected with the trade. The boys are also encouraged to attend evening school, especially to study drafting and mathematics; more than a third of them are now pursuing such studies in a systematic manner. There is a free library for the use of the shop, containing, besides books of general literature, many valuable works on mechanical subjects. A "Handbook for Apprenticed Machinists," written by Oscar J. Beale and published by the company, is put in the hands of every apprentice. It contains valuable information of a practical nature that can be better learned from a book than from other forms of instruction.

It is of great importance that *some one* should have a special interest in the welfare and progress of the apprentices, aside from following up their work from day to day. In the early days of the business this responsibility was assumed by the superintendent of the company. It was not only because he appreciated the value to the company of a loyal and well trained force of young men growing up to fill places of responsibility, but also because of a *personal interest* in the boys that he helped them, both in and out of the shop. Many a man now advanced to a position of trust and responsibility can date his start on the upward path from the kindly, forceful words of counsel or admonition from his superintendent. He still retains his in-

terest in the boys, although the growth of the business has made it necessary to have a man that can devote all of his time to this branch of the work.

A Superintendent of Apprentices.—Some of the foremen felt that if such a position were created, they would be interfered with in the management of their departments and that there would be a conflict of authority. The superintendent urged the adoption of such a plan for some time before these objections were set aside and the plan tried. It has proved so successful that no one would now wish to see it abandoned. This instructor, perhaps better named "superintendent of apprentices," is employed to have general oversight of the boys. He examines those seeking admission, to ascertain their fitness for the work, and explains fully to them and to their parents or guardians the requirements, so that there may be no misunderstanding. It is important that only such boys be indentured as show an interest in their work and an ambition to learn the trade. Boys brought by their parents who wish them to serve an apprenticeship because they will not attend school are, in most cases, poor material with which to work. Care in selection at the beginning goes far towards insuring success.

The man in charge of the apprentice acts as instructor in some of the rudiments of the trade, in the care of machinery, the proper form and use of tools, and in the best ways of doing the various kinds of work. This is not to relieve the foreman of any responsibility in regard to the boys, but as an additional help to both. Although the main work of instruction comes under the foreman and sub-foremen in the department where the boy is working, there are other points needing attention that come outside their regular duties. These can be better cared for by one man having an oversight of all the boys. He can keep an eye on their habits, especially those of boys living away from home, and see that they have proper care in case of sickness. He can often help them over hard places both in and out of the shop, and can guide them on the road to greater usefulness to themselves and their employers. He can encourage them to be neat, careful, and quick in their work, to study such subjects as will help them to advance, and so to apply themselves as eventually to become masters of their trade; he can see that they have justice and a uniformity of treatment. Even in small shops, where the whole time of one man would not be required for such work, it should be the duty of some one to give what time is needed to it.

It should not be expected that the system successful in one department will suit the needs of all others, to say nothing of one shop

working exactly along the lines of another. This stretching out for one, and chopping off for another, as if to fit the fabled "Procrustean Bed" results only in mutilation. Each must study his own needs and adapt a system to his special conditions.

Apprentices in Drafting.—In the drafting room there is a form of apprenticeship adapted to the special needs of that department. Here the time of service is two and one-half years, six months of which is spent in the machine shop. The apprentice first enters the drafting room and, after working there for five months, is transferred to the shop where he is instructed in the work of the different departments. It is not expected to turn out machinists in this short time. The intention is to familiarize these boys somewhat with shop methods, with the use of tools, and with the operation of machines, so that they may have a better appreciation of the work they will be called on to do when they return to the drafting department; also that they may avoid some of the mistakes characteristic of draftsmen without shop training, mistakes showing inexperience and lack of practical knowledge, mistakes that hold some draftsmen up to ridicule among the men in the shop.

Boys, before being accepted as apprentices in the drafting department, must have had sufficient technical or other preliminary training already to have mastered the rudiments of drafting. When the boy has served a full apprenticeship in the machine shop before entering the drafting room, the time is shortened and he is not required to serve further in the shop. The usual age for entering the drafting department is from 19 to 22 years, and the pay from 10 cents per hour at the start to 17 cents during the latter part of the time. The sum of $50 is paid at the close of the apprenticeship, if merited, as a reward for faithful service.

Core-Makers' Apprentices.—Another recent development of the system to meet new conditions is the taking of apprentices into the core-making department of the foundry. It was found that experienced workmen for this department were not available. To insure a supply, it was decided to take apprentices to learn the core-maker's trade in a thorough manner. The ordinary form of apprenticeship did not seem suited to such work. It was thought desirable to have apprentices start at a more advanced age, from 18 to 22 years, so the time of service was made 3 years only. As this trade does not give as great an opportunity for future advancement, not holding out as great inducements to enter it, the wages were made higher than for the regular apprenticeship as machinist, commencing at 12 cents per hour and reaching 18 cents.

The payment of $40 required at the commencement for the privilege of learning the trade can be made in weekly installments of one dollar each, if desired. A bonus of $140 is paid at the end for faithful service.

The apprentices in the pattern shop are given an experience of several months in the foundry and core room during the second year of their service.

American Boys as Apprentices.—The assertion has repeatedly been made that American boys will not serve an apprenticeship, and that American shops are being filled with foreign workmen. The experience of this company does not seem to bear out such a statement. A large percentage of the boys are American-born.

Some years ago a letter was published in the *American Machinist*, asking for a boy to serve an apprenticeship in a small shop in Ohio. About a year later the proprietor wrote:—

> "We were overwhelmed with letters, most of them very intelligent too, from Maine to British Columbia, North and South. We made a selection and one we are well pleased with. If employers would give more attention to procuring worthy apprentices, and after trial reject those not well qualified, the shops would soon be filled with better workmen."

If it be true that there is a feeling among American boys that all the prizes of life are to be found in the professional and mercantile callings, and that boys of ability are turning in these directions, it makes the opportunity all the greater along mechanical lines for those that would seek the best openings for advancement. That the future is large in possibilities along these lines scarcely need be stated.

The School Shop as a Substitute.—For many years, Prof. John E. Sweet has recommended the "school shop" as a substitute for the apprenticeship system, regarding it as the best way to keep up the supply of skilled mechanics, and in a recent paper read before the Metal Trades' Association of Syracuse, he again sets forth his reasons for such a plan; the alternative he sees is for the boy to pay a tuition for the privilege of learning his trade in the machine shop, as he would if pursuing a college course. Prof. Milton P. Higgins also advocates the school shop. He presented a paper before the convention of the National Educational Association held in Boston last summer, explaining the needs and working of such a plan. The arguments advanced in favor of such schools are based, largely, on the supposition that the apprenticeship system is dead, giving no opportunity for a boy to learn the machinists' trade, because manufacturers

cannot afford to be troubled with apprentices—that the investment per machine is now so high that it is not economical to put such machines in the hands of learners—that work is so specialized that, if apprentices are employed, they will be kept on one operation or on one machine and will not learn the trade properly.

That some of these arguments have weight, and must be considered, cannot be denied. That cases exist where it is not practical or economical to take apprentices is, no doubt, true. It is evident that there is a field for the extension of school training made more practical and as near as possible to real work.

There is much that is hopeful in the modern development of our school system and in these proposed plans for its further extension along practical lines, but it does not seem that such plans can give the equivalent in training of a service of apprenticeship such as has just been described, especially in cases where the apprentice adds to his experience in the shop the school knowledge he gets by evening study.

The boy coming from the school shop, no matter how good his training, must start as an unknown quantity with his new employer and win his way from the beginning. The boy already four years in the service of an employer as apprentice may have won his confidence and esteem; he may have developed such ability and shown such a spirit of loyalty as to have put him in the line of promotion even before he completes his apprenticeship. There is no better way to maintain the vitality and keep up the standard of a shop than by training young men in the shop itself, preparing them to assume the responsibilities later on. If not profitable otherwise, it is worth more than all it costs for this alone. That *it is often profitable* is shown by the following opinion of a shop foreman—it is but one among many; he says:—

> "These bright, active apprentice boys are really of more value in a shop than many of the regular journeymen. They are ambitious to learn and to excel and, when properly encouraged, will get out as much work as some men who have been at the trade a dozen years."

It may be that in time the standard for admission to shop apprenticeship can be so raised as to require a special school training, fitting the boy for entrance to the shop, in a way similar to that now required for entrance to the drafting room just described. There is a suggestion of this in the fact that graduates of the Providence Manual Training High School, coming well recommended by the principal, may have the term of apprenticeship in the machine shop shortened. With an extension of such schools as recommended by Professors Sweet and Higgins, still further steps in this direction might be

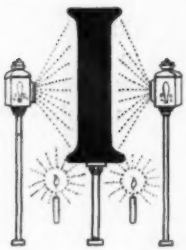
taken, steps to *strengthen,* rather than to *supplant,* the apprenticeship system.

The influence of the schools is shown in many of the modern forms of apprenticeship. In such systems as exist at the Westinghouse Company, the apprentices are divided into classes according to education. Such a system seems well adapted to the needs of large works requiring, besides workmen, a number of technically educated experts. The Baldwin Locomotive Works find the system suited to their needs to be one having three classes of apprentices and combining a course of evening study as a required part of the training. In many lines of mechanical work, such an elaboration of the system would not, of course, be required, especially among the smaller shops. It does seem, however, that there should be a more definite agreement than now exists in many places nominally taking apprentices; that this should be in the form of a written agreement, as to time of service and wages, with a money forfeiture in case of failure on the part of the apprentice to fulfill his agreement, and with a reward at the end for faithful service; and that there should be a personal interest taken in the boy throughout his apprenticeship. It is my opinion that the best results in the development of the modern apprenticeship system can be thus attained.

THE HOMES OF THE GREAT ENGINEERING SOCIETIES.

By Henry Harrison Suplee.

At the present time the value of association for the development of engineering work is fully understood, and in nearly all civilized countries organizations exist, devoted to the work of different branches of the profession. Some of these have attained a sufficient measure of success to be able to possess homes in which to hold their meetings and to house their libraries and other belongings, and from among these we have selected some of the most noteworthy in the belief that the features which have commended themselves to experience may be of interest and value to those who are considering the construction of a society home and headquarters.—The Editors.



It was not until early in the nineteenth century that the engineer, the man who above all others was destined to change the face of the civilized earth, really attained such a professional position as to feel himself qualified to form an association for the exchange of opinions and the furtherance of his work, and it was in England, the home of some of the greatest engineering developments, that the first of the national engineering societies, the Institution of Civil Engineers, was founded, the date of its foundation being January 2, 1818.

According to an interesting historical account of the Institution, published in the Proceedings of the Institution for 1886, and presumably from the pen of the Honorary Secretary, Mr. James Forrest, the first formal meeting was held in the Kendal Coffee House, in Fleet Street, and the persons who took the initiative in forming the society were six young men, then beginning their engineering life; William Maudslay, Joshua Field, Henry Robinson Palmer, James Jones, Charles Collinge, and James Ashwell. For two years these, and others who joined them, continued to meet, and the success which they gained by the interchange of experience encouraged them to endeavor to extend their work by a bold stroke. This was to offer the presidency of the Institution to the foremost civil engineer of the time, Thomas Telford, and thus at one leap to attain a prominence hitherto lacking. The following resolution, passed on January 23rd, 1820, is the record of this action:

THE INSTITUTION OF CIVIL ENGINEERS.

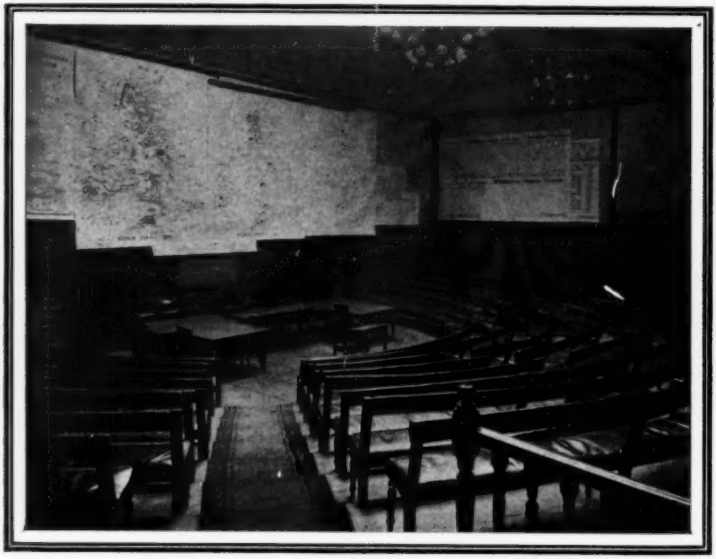
Great George Street, Westminster, on the prolongation of which a short distance beyond is the building of the Institution of Mechanical Engineers. The portrait busts on the upper portion of the façade are those of eminent British engineers.

"That in order to give effect to the principle of the Institution and to render its advantages more general, both to the members and the country at large, it is expedient to extend its provisions by the election of a President whose extensive practice as a civil engineer has gained him a first-rate celebrity, and that a respectful communication be made to Thomas Telford, Esq., Civil Engineer, requesting him to patronize this Institution by taking upon himself the office of President."

Although Telford had never heard of the society before, he accepted the nomination, and was duly installed, and under his care and reputation the Institution developed to such a degree that in 1828 it received a Royal charter of incorporation. Telford continued to evince a deep interest in the work of the Institution until his death in 1834.

According to the original "Regulations" the Institution was declared to have been formed "for facilitating the acquirement of professional knowledge, and for promoting mechanical philosophy." In the charter of 1828, however, the Institution is stated to have been established:

"For the general advancement of mechanical science, and more particularly for promoting the acquisition of that species of knowledge



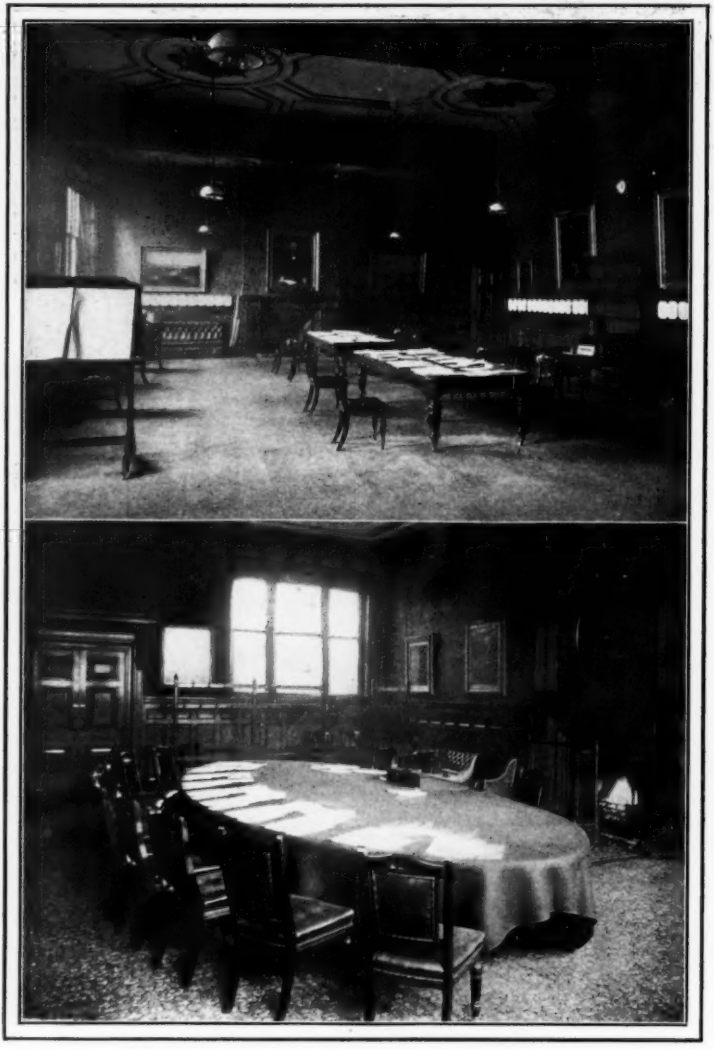
THE MEETING ROOM, IN THE INSTITUTION OF CIVIL ENGINEERS.

THE MAIN STAIRCASE, INSTITUTION OF CIVIL ENGINEERS.

The scene of many brilliant and distinguished gatherings at the receptions of the Institution.

which constitutes the profession of a Civil Engineer; being the art of directing the great sources of power in Nature for the use and convenience of man, as the means of production and of traffic in States, both for external and internal trade, as applied in the construction of roads, bridges, aqueducts, canals, river-navigation and docks, for internal intercourse and exchange; and in the construction of ports, harbours, moles, breakwaters, and lighthouses, and in the art of navigation by artificial power for the purposes of commerce; and in the construction and adaptation of machinery; and in the drainage of cities and towns."

This exhaustive definition of the work of the civil engineer is believed to be from the pen of Tredgold, and it has been more or less accurately quoted many times since. When it is considered that it was written in the year before the Rocket made its triumphant run at Rainhill, when steam navigation was at its beginnings, when the science of applied electricity was undreamed of—in short, in the infancy of engineering as it is now understood—the scope which it gave to the profession is remarkable. That is has since been sought to limit the work of the civil engineer to a smaller portion of this field is a matter



THE INSTITUTION OF CIVIL ENGINEERS.

The upper picture shows the periodical reading room, and the lower the council chamber, over the table of which hangs the portrait of Telford.

for regret, but there is now every evidence that the various branches of the profession in English-speaking countries are destined to join in their work and their associations to an extent fully as great as exists to-day in France or in Germany. Broadly, the term "civil engineer" was originally intended to differentiate the engineer in civil practice from the engineer in military service; the one "directing the great sources of power in Nature for the use and convenience of man," and the other exerting himself to divert the same great sources of power to the misuse and inconvenience of man.

The Institution of Civil Engineers at first occupied rented rooms at 15, Buckingham St., Adelphi, but in 1834 the members aspired to own a home of their own, and a small house at No. 1, Cannon Row, Westminster, was taken. These quarters gradually became inadequate, and on Christmas, 1838, the site of the present handsome house was first occupied, the house at 25, Great George St., Westminster, being taken, and a meeting room about 30 feet square being built in the rear of the front house. In 1865 the question of a new house was agitated, and in 1868 the adjoining property, No. 24, was secured and the house enlarged and practically rebuilt.

The present fine building stands upon the same site as its predecessors, a third house having been acquired, and an entirely new structure erected in 1894-1896 from designs by the late Mr. Charles Barry. The cost of the building was about £50,000, and the site is valued at about as much again, so that the present value of the premises may be taken as about £100,000. This building contains a fine theatre or general meeting hall, ample room for the library, together with offices, council room, store rooms, and quarters for the housekeeper. The Institution is fortunate in the possession of a great number of fine portraits of eminent engineers and members, and these hang on the walls of the meeting rooms and the other rooms, while at the head of the great staircase is a marble tablet upon which is inscribed the list of names of the successive presidents of the Institution, this forming practically a roll of honor of the most eminent names in the profession.

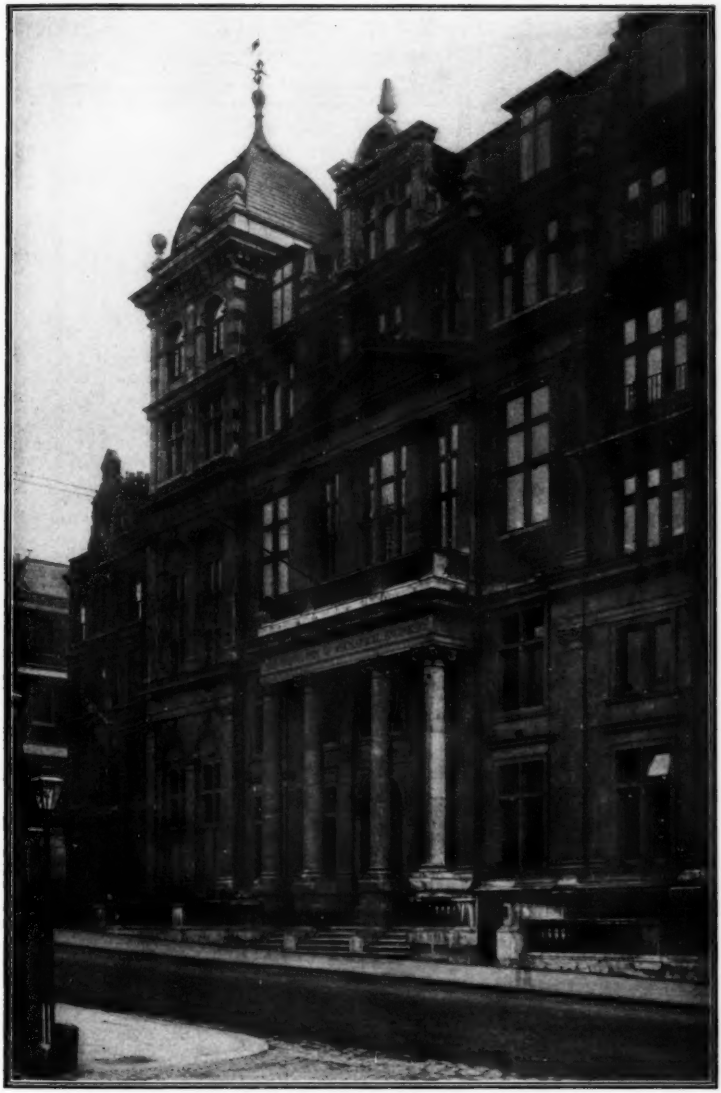
In addition to the names of the presidents, it is well understood that the secretary is the man to whom falls the laboring oar in the propulsion of the work, and the Institution of Civil Engineers can regard with equal pride its list of presidents and secretaries. The first of the secretaries since the Institution occupied an important position was Mr. Thomas Webster, Q. C., the father of the present Chief Justice, Lord Alverstone. His successor was Mr. Charles Manby, whose work and acquaintance with engineers at home and abroad did much to

further the progress of the Institution. Mr. Manby was succeeded in 1856 by Mr. James Forrest, beloved alike in Great Britain and in the United States for his kindly personality and for his enthusiastic work for the advancement of the engineerng profession. Mr. Forrest continued in active service until 1896, when he was made honorary secretary, being followed by Dr. J. H. T. Tudsbery, the present incumbent, most efficient and helpful to all who come in contact with him in the administration of his work.

THE LIBRARY OF THE INSTITUTION OF CIVIL ENGINEERS.

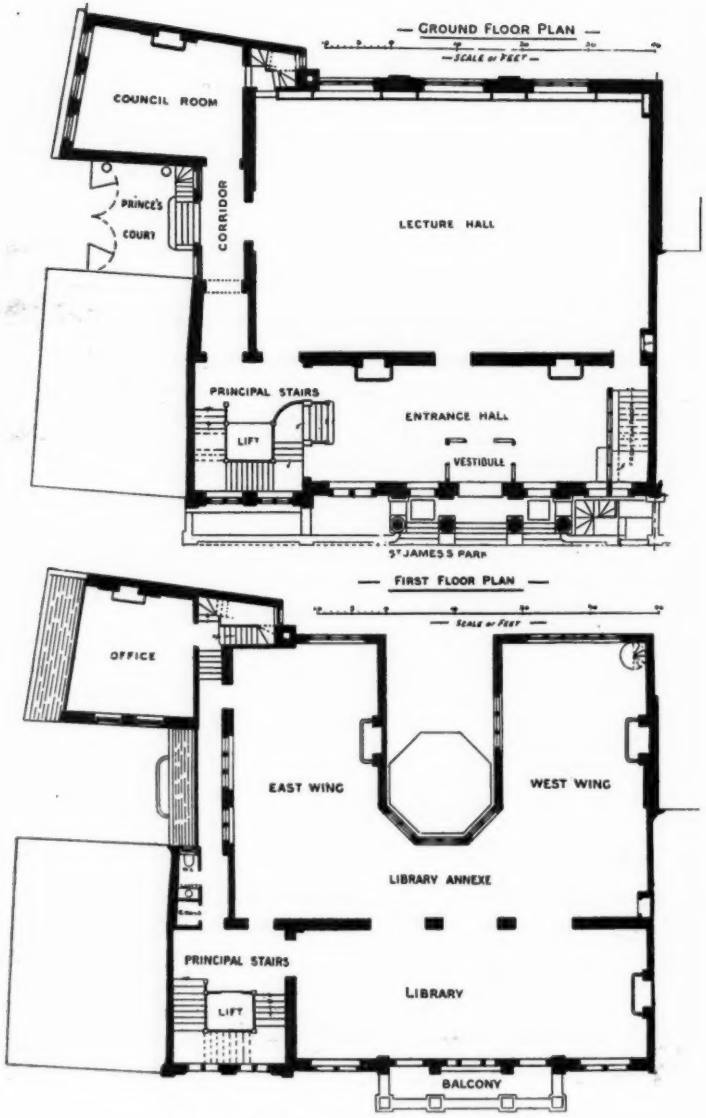
The library of the Institution, having its origin in the bequest of his books by Telford, is now estimated to contain 55,000 volumes and 15,000 pamphlets, and practically every standard work on engineering in the English language is to be found there, as well as many in other languages. Being constantly augmented by the presentation of copies of the works of the members as well as by purchase, it is doubtless the most complete general engineering library in existence at the present day.

The Institution of Mechanical Engineers, the sister society and near neighbor of the Institution of Civil Engineers, had its origin not in London, but in Birmingham; the first general meeting there being the result either of a gathering of engineers at the house of Mr. Beyer



THE INSTITUTION OF MECHANICAL ENGINEERS.

Storey's Gate is seen (in part) just beyond the corner of the adjoining building on the right. Birdcage Walk, passing in front of the Institution, leads through the gate into Great George Street, a short distance down which, on the left, is the Institution of Civil Engineers.



INSTITUTION OF MECHANICAL ENGINEERS.

The arrangement of the bay in the library provides for overhead lighting of the hall below and also light and air for the library wings. Note the convenient communication of the council chamber with the hall and with the office of the secretary.

in Manchester, or at the residence of Mr. McConnell, near Bromsgrove. The organization meeting was held at the Queen's Hotel in Birmingham, on January 27th, 1847, and at this meeting Mr. George Stephenson was elected by acclamation the first president. For several years the society continued to meet in Birmingham, the membership reaching about two hundred, when, in 1856, through the efforts of Mr. James Fenton, a member of the Council, the plan was adopted of holding summer meetings at various engineering centres, the first of these meetings being held at Glasgow under the presidency of Mr. Joseph Whitworth. The effect of these meetings was a rapidly increasing interest and activity among the members, the membership growing steadily, until, in 1877, when the society removed from Birmingham to London, there were more than a thousand members.

No attempt was made at first to secure a house for the Institution, rooms for the business staff and the library being obtained at 19, Victoria St., Westminster, and the London meetings being held in the hall of the Institution of Civil Engineers by the courtesy of that society, an evidence of the good will and hearty co-operation which has always existed between the older and younger organizations.

An important department of the work of the Institution of Mechanical Engineers has been conducted by its various research committees, these investigations including experimental studies of the strength of riveted joints, the hardening and tempering of steel, friction at high velocities, marine-engine trials, steam jackets, gas engines, and the properties of alloys. Since 1879 upwards of £4,000 has been spent in these researches, the expenditures in all cases being limited to the working costs, the numerous and eminent members who have served on these committees giving their services gratuitously.

Since 1899 the Institution has occupied its present handsome building, situated at Storey's Gate, St. James' Park, Westminster, being on the prolongation of Great George St., which, after passing Storey's Gate, is called the Birdcage Walk. The building is thus within a stone's throw of the house of the Institution of Civil Engineers, and yet possesses the advantage of a front overlooking a Royal Park, with a magnificent view over the Horse Guards Parade. It is in close proximity to important government offices, including the Foreign Office, the Office of Works, and the new Admiralty Buildings.

The general appearance of the house is well seen from the illustrations, while the arrangements are well adapted for its purposes. The main hall is ingeniously provided with a floor built up of movable platforms or boxes, which, when uniformly distributed, provide a level

floor, flush with the vestibule without, while by suitable arrangement they may be built up into a series of terraces for conversion of the room into an auditorium for meetings. By this simple contrivance a single large room is made available at short notice either as a theatre or as a reception room. The Institution at present possesses a library of about 10,000 volumes, most conveniently arranged in alcoves on the first floor, these rooms being very handsomely finished in Hungarian oak. An electric lift is placed in the middle of the shaft for the main stairway, both lift and stairway being fitted with artistically forged iron-work grilling.

THE MEETING HALL, IN THE INSTITUTION OF MECHANICAL ENGINEERS.

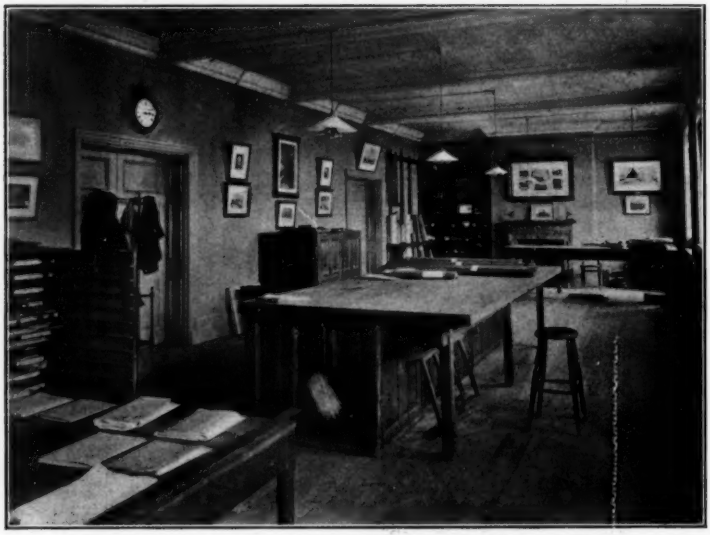
The door at the rear of the stage leads through a corridor to the council room. At the window on the right is seen one of the ground-glass screens behind which the ventilating and warming current is admitted.

An interesting feature of the building is the system of ventilation, the fresh air being drawn in from the park by an electrically-driven fan, and after passing through fibre screens over which a sheet of water is kept flowing, it is passed over radiators and delivered into the main hall through passages formed between the windows and glass screens placed in front. In this way all draughts are avoided, while the air is at the same time delivered at points where its warmth can

THE INSTITUTION OF MECHANICAL ENGINEERS.

Below is seen the entrance hall, the tablet on the right bearing the names of the presidents of the Institution. Above is a part of the library.

counteract the chilling effects of the windows. An important portion of the building is found on the upper floor, where there is provided a drawing room especially adapted for the rapid production of large wall diagrams and drawings in connection with the presentation of papers, and there is also a meeting room for the "graduate" members of the Institution. This plan of providing for the junior members a room which they may feel belongs especially to them for their own gatherings, appears to be a most desirable feature, worthy of imitation elsewhere.



THE DRAWING OFFICE, INSTITUTION OF MECHANICAL ENGINEERS.

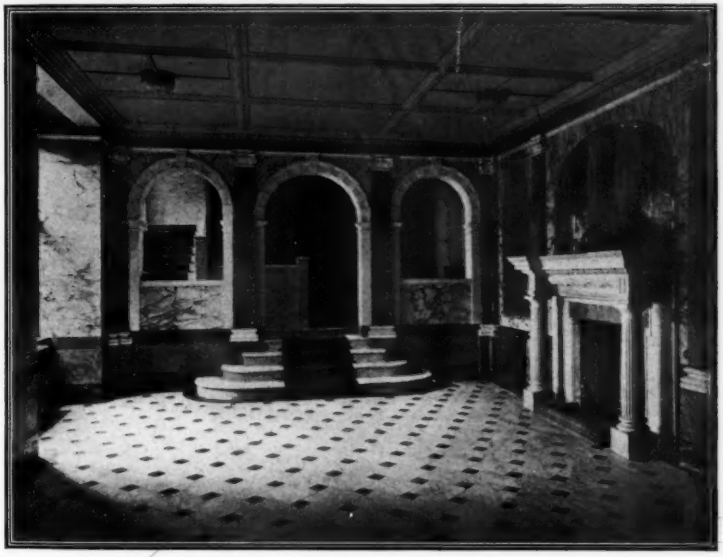
The secretary's office is especially commodious and convenient, while beneath it, and in close proximity to the principal meeting room, is the council chamber, both this room and the office of the secretary being given private communication with the main hall.

One of the most beautiful portions of the house is found in the so-called "tea room" in the entresol, this running under the full length of the entrance hall. This room is lined throughout with costly marbles, new and rare stones having been selected in order to produce the most striking effects. The general style of the room is Italian; the pilasters are of antique sienna with statuary white caps and bases, while the surbase is of dark dove, with dado of cippolino and verte antique plinth. The panels are of picked Mexican onyx, showing

beautiful veining, and the whole effect of the room is most artistic. Here the refreshments are served during the conversazioni held during the season, there being a convenient kitchen and pantry adjoining.

In the basement there has been made ample storage provision for "proceedings" and other papers, together with a fine lavatory, and arrangements for large coat rooms, these features often being given insufficient consideration in the design of such buildings.

The result of experience with this building since its occupation by the Institution shows it to be excellently adapted for its purposes, and there are numerous details in its construction which might well be considered in the planning of structures for similar uses elsewhere. Mr. Edgar Worthington, the present secretary, with his assistants, has succeeded in organizing the operative administration of the Institution in a highly efficient manner, and among the great engineering societies of the world the Institution holds a prominent position.



THE TEA ROOM OF THE INSTITUTION OF MECHANICAL ENGINEERS.

Passing to the Continent, we find that the differentiation between the various branches of the work of the engineer, however far it may have been carried in practice, has not extended to the professional societies to the same extent as obtains either in England or in the United States. The Société des Ingénieurs Civils de France un-

SOCIÉTÉ DES INGÉNIEURS CIVILS DE FRANCE.

Façade of the building on the Rue Blanche. This street leads directly to the Rue de la Chaussée d'Antin and to the Boulevards and the heart of Paris.

doubtedly represents the whole of the profession in its country; while the Verein Deutscher Ingenieure is not only the national engineering society of Germany, but by its system of organizing local branches, or "Bezirksvereine" it has carried the influence of professional engineering associations to a wider scope than exists in any other country. Both of these societies possess handsome modern houses, and it is believed that some account of these establishments in Paris and in Berlin may well follow those of the homes of the British societies.

The Société des Ingénieurs Civils de France, like many other liberal institutions on the Continent, had its origin in the stormy year

1848, when the newly recovered freedom of thought and action vented itself in the establishment of bodies which have since had a profound influence upon national life and activity. It was on March 4, within a month after the revolution of February 1848, that a group of former pupils of the Ecole Centrale met and formed the society of civil engineers which since that date has grown to be the representative organization of all branches of the work of the engineer in France.

SOCIÉTÉ DES INGÉNIEURS CIVILS DE FRANCE.

View from outer lobby, showing the relation of the main hall and inner lobby to the entrance; the visitor is just entering from the street.

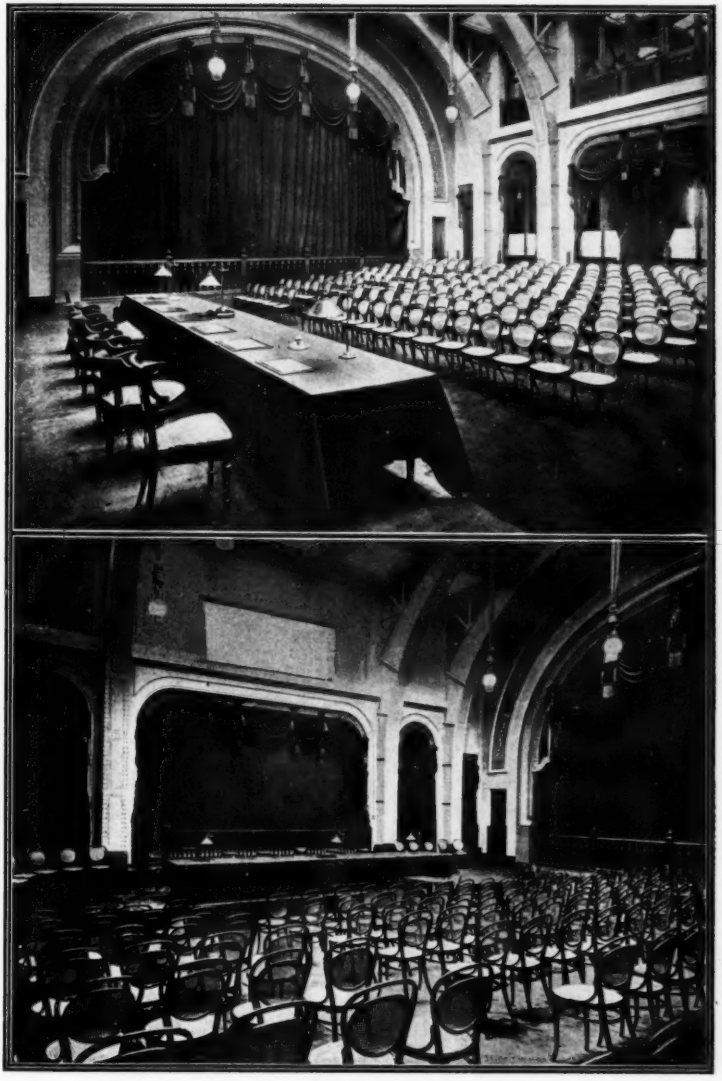
The early meetings of the society were at various places; at the rooms of the Société d'Encouragement, then in the Rue du Bac, in the Rue Duphot, the Rue des Bons Enfants, and at the Imprimerie Chaix, in the Rue Bergère. The papers and archives of the society were in charge of M. Husquin de Rhéville, who continued to act as

secretary-archivist until his death in 1887, while the first president was M. Eugene Flachat, who held this office seven different times, the last being in 1867, and was honorary president from 1868 until his death in 1873. The original founders of the society in 1848 numbered one hundred and thirty-five, and according to the catalogue of 1903 but twelve of these are now living.

After remaining in the quarters in the Rue Bergère for 18 months the society sought larger accommodations, and rented a house at No. 26, Rue de Buffault, where for twenty-two years it remained, although during the latter portion of this time, when the membership numbered nearly one thousand, the rooms were often uncomfortably crowded. In 1868, following closely upon the impetus given to the work of the society by the exposition of 1867, a site was obtained in the Cité Rougement, just off the Boulevard Poissonnière, and a new building was planned and partly completed when the events of 1870-1871 caused work to be suspended. The new building was finally opened in the summer of 1872, and remained the home of the society until 1897, when the present handsome building in the Rue Blanche was opened with appropriate ceremonies. The construction of a new building was decided in 1895, and its erection was accelerated by the opportunity for the sale of the existing property, with the requirement for early delivery. As a matter of fact the building was finished in 262 days from the time that the site was cleared, being opened for use on January 14, 1897; the old house having been given up on the 15th of December preceding.

The appearance of the house of the Société is well shown by the illustrations, but there are several details which demand especial attention. The main auditorium, with its arched girders, is an excellent example of the manner in which constructive features can be artistically treated without concealment, and the lighting and the acoustic properties of the room are also excellent.

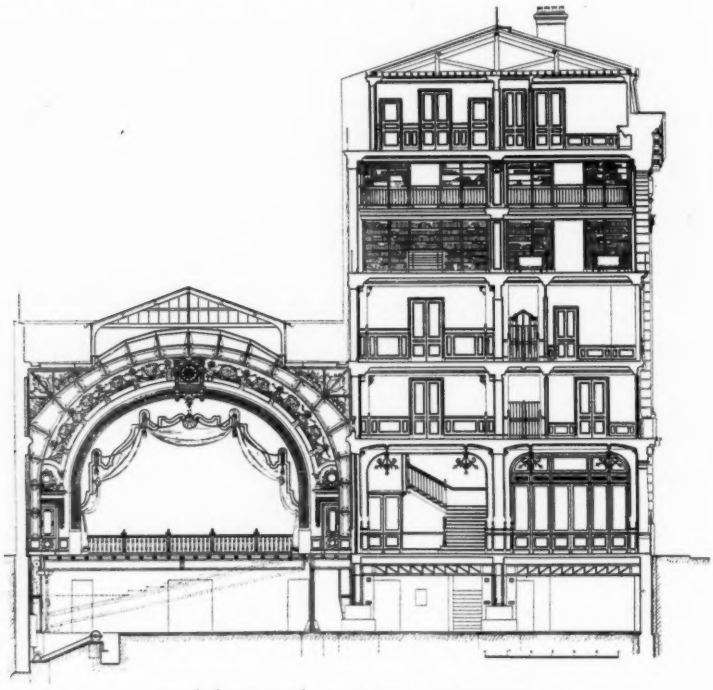
The method of converting the meeting hall from a reception room into an auditorium in the case of the building of the Institution of Mechanical Engineers has already been described, and a similar result is attained by altogether different means in the present instance. The floor of the large hall is supported upon stiff girders which are hinged at the rear end of the room, and counterbalanced by a system of weights and chains at the front, near the platform. By the use of a pair of winches, the floor, weighing about thirty tons, may readily be raised into a level position, being then firmly supported upon adjustable posts; or, in a few minutes it may be lowered into a suitable



SOCIÉTÉ DES INGÉNIEURS CIVILS DE FRANCE.

Main hall, showing the inclined floor. The upper view is from the platform and the lower from the rear of the hall. The curtain is fireproof and separates the annex from the hall when lowered. The gallery at the rear (upper view) forms a part of the smoking and conversation room in the entresol.

incline for use as an auditorium. This convenient mechanism has been found to work exceedingly well in practice.

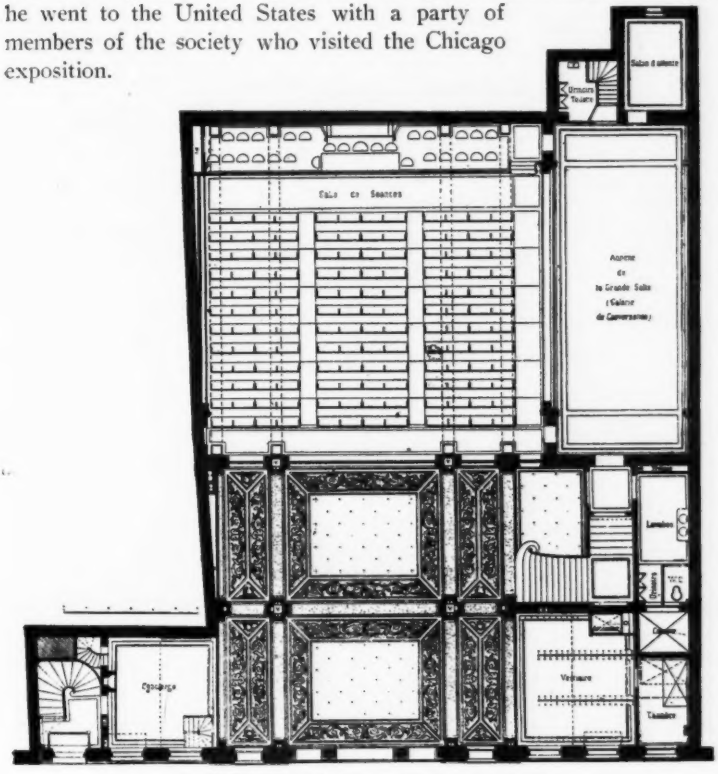


SOCIÉTÉ DES INGÉNIEURS CIVILS DE FRANCE.

Cross section of the building, showing the moveable floor of the meeting hall, and the arrangement of the library and residence of the secretary above the business offices, council room, and general conversation room.

The general arrangement of the building is as follows. In the basement is placed the machinery and the storage space for papers and archives. The ground floor is devoted to the entrance vestibule and lobby and the main auditorium and annexes, with the intention of avoiding the crowding of the main staircase upon occasions of importance. In the entresol are placed the rooms more generally used by the members, including a conversation room, reading and smoking rooms, and a commodious gallery overlooking the auditorium. The floor above is devoted to the business of the society, including the private offices of the president and the secretary, the council chamber, and the general offices for the transaction of business with the public.

The two floors above are devoted to the library, while the top floor is fitted up as a convenient suite of apartments for the residence of the secretary. A private staircase, with separate entrance from the street, gives access to the office of the president and to the apartments of the secretary, while an electric elevator also gives access to all floors. The main stairway, for the general use of the members and public, forms one of the features of the house, and the artistic decoration of the whole is most effective. M. Armand de Dax, the present secrétaire administratif, who succeeded M. Husquin de Rhéville in 1887, is well and favorably known to engineers in Europe and America, and in 1893 he went to the United States with a party of members of the society who visited the Chicago exposition.



SOCIÉTÉ DES INGÉNIEURS CIVILS DE FRANCE.

Ground plan, showing lobby, meeting hall, coat room, staircase, etc. This arrangement permits of receptions, meetings, and the like, without the use of any stairway whatever, the receiving line being in the inner lobby after leaving the coat room and before reaching the main hall.

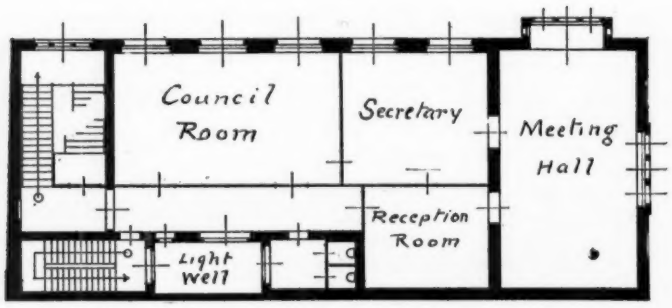
The Verein Deutscher Ingenieure differs materially in its composition and methods of work from any of the other national engineering societies, and hence its requirements are by no means the same as obtain in London or Paris. The system of "Bezirksvereine" or local branches in various cities and districts of the empire provides for a large portion of the professional activity of the society, and the general

SOCIÉTÉ DES INGÉNIEURS CIVILS DE FRANCE.

Inner lobby, showing the effect of the great mirror. The street entrance is on the left and the entrance to the main hall on the right, the view being taken from the base of the grand stairway.

meetings are held yearly in different cities, so that a large general meeting hall in Berlin is not required, provided sufficient accommodation for the local branch is made. Furthermore, the society publishes what is undoubtedly one of the most complete and valuable weekly engineering periodicals to be found in any country, this including the more important contributions presented at the meetings of the society, together with additional papers and articles, and general current engineering information. This renders the editorial feature of the work of the secretary a preponderating feature, and Baurat Peters, the energetic and experienced director of the society, has shown himself most efficient in this important portion of the work. With a

THE VEREIN DEUTSCHER INGENIEURE.



PLAN OF THE SOCIETY ROOMS, VEREIN DEUTSCHER INGENIEURE.

The floor above is occupied by the editorial offices of the *Zeitschrift*, and the top floor by the photo-engraving plant. The lower floors are given up to residence or business purposes.

total strength of more than 17,000 members covering practically all branches of the profession, and with 42 local working sections in all parts of the empire, as well as more than 4,000 members not attached to local branches, the Verein Deutscher Ingenieure is without doubt the largest and most active engineering society in the world.

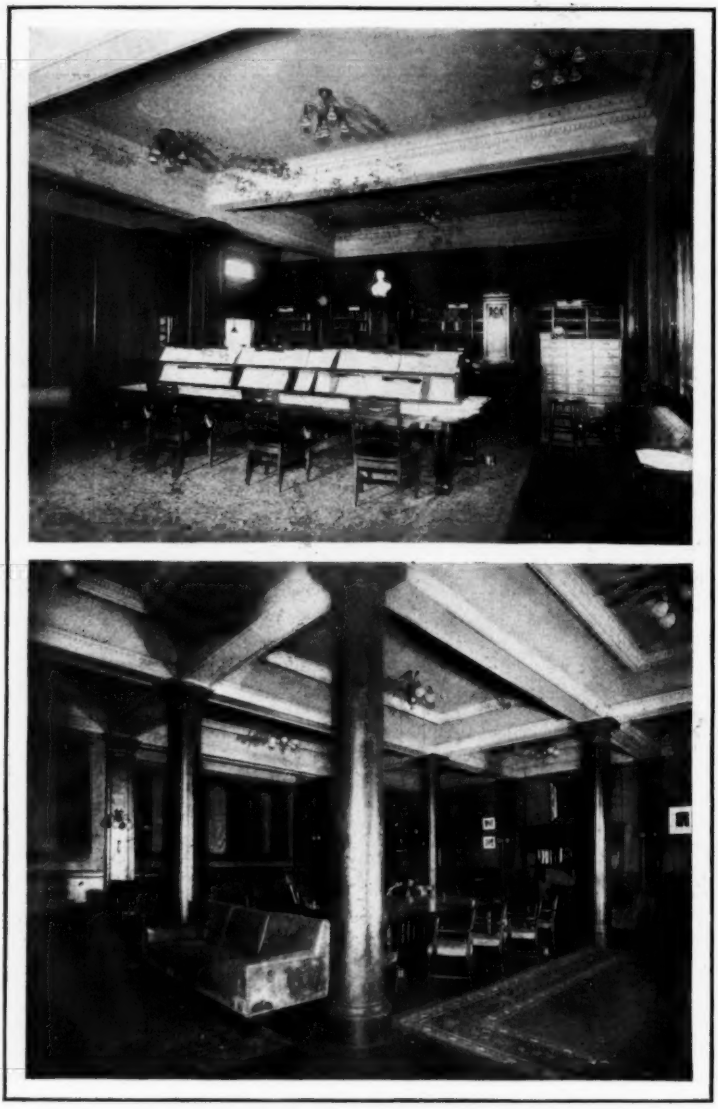
Its annual conventions being held in various cities, no especial provision is made in the new building at Berlin for the accommodation of anything like the full attendance on such occasions. The headquarters are rather a set of working offices for the administration of the society's affairs, for the editorial department of the *Zeitschrift*, and for the meetings of the Berlin section.

The new house of the "Verein" is a handsome sandstone structure situated on the Charlottenstrasse, one of the most desirable streets of Berlin, and is an excellent example of a business headquarters for such an organization. The basement is fitted up for storage purposes, while the ground floor and floor above are arranged to be rented for business purposes, thus bringing in a substantial income.

On the second floor is situated the meeting room, of ample size for the needs of the Berlin section, and on this floor are also found rooms for the meetings of the directors, as well as suitable waiting rooms. The third floor is wholly devoted to the editorial rooms of the *Zeitschrift*, while above are reading and drawing rooms and a photographic studio.

The only one of the four National engineering societies in the United States which possesses a building especially designed and constructed for its use is the American Society of Civil Engineers, this handsome structure being situated on West Fifty-seventh St., in New

THE AMERICAN SOCIETY OF CIVIL ENGINEERS.



THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

The lower picture shows the board and committee room, used also as a reception room. This is directly below the main meeting room. The upper view is the main reading room of the library; the stack room is above.

THE CORRIDOR, HOUSE OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

At the rear is seen the board and committee room, above which, on the next floor, is the main meeting hall. The library is over the corridor.

York. The house is arranged as shown in the illustrations, with entrance lobby, coat room, and reception rooms on the ground floor, while back of these is a large room, originally designed as a lounge and smoking room, but since used for the board and committee room.

The first floor contains the main meeting hall, directly over the board room, and also the reading room, and the office of the secretary, while on the two floors above are situated the executive and editorial rooms and the book stack of the library. The current periodicals, as well as certain books of reference and new books are kept in the reading room, while the dumb-waiter connection to the top floor enables books from the stack to be supplied promptly upon call.

Electric lighting is supplied from an isolated plant in the basement, there being two gas engines of 25 horse power each, with direct-connected dynamos.

The area of the ground on which the building stands is 50 feet front, by 110 feet deep, and the total cost of house and ground is a little more than $200,000.

THE LIMITS AND POSSIBILITIES OF DEEP MINING.

By E. H. Roberton.

No better suggestion of the importance of deep mining could be supplied than that provided by Professor Redmayne's articles on the coal industry, which appeared in our October, November, and December issues. The question of fuel exhaustion depends largely on the depth to which the coal deposits of Great Britain can be worked. Elsewhere, as at Lake Superior and on the Rand, the subject has immense importance in metal mining. Mr. Roberton deals instructively with the mechanical aspects of the problem.—THE EDITORS.

THE exhaustion of the more superficial deposits of coal and other minerals brings into prominence one of the most interesting latter-day problems of scientific engineering—the study of the limits and possibilities of deep mine work. The difficulties with which the mining engineer has to contend are, briefly, the increases in temperature and pressure due to depth, and the various mechanical problems connected with the economical extraction of the mineral. Of these it is probable that the natural forces of temperature and pressure will prove the more formidable.

Although it is true that in the deep levels of the Tamarack mine, in the Lake Superior district, the temperature at a depth of over 5,000 feet is quite moderate, being only 78 degrees, it is unfortunately also true that in the deep mining practised in other districts, experience goes to prove a steady increase in temperature as the mine proceeds to depth. Great stress is being laid on the subject of the temperature of deep mines, by the Royal Coal Commission, now sitting, and the evidence so far adduced points decidedly to a limit to deep mine work on that score alone. The rate of increase of temperature, however, varies even for the same locality in a bewildering way. This will be seen on reference to the chart, where the records taken at different times, in the same mine workings, trace curves that prove to be quite different from each other on the chart.

At Pendleton Colliery, where the workings have reached a depth of 3,500 feet, the temperature of the working places is as high as 93 degrees, and that of the rock itself is 100 degrees. The rate of increase in the inclined bed of this mine is 1 degree for every 40 feet of descent. This is an exceptional case, and much above the average. At a sinking at Rosebridge Collieries, near Wigan, the increase of tem-

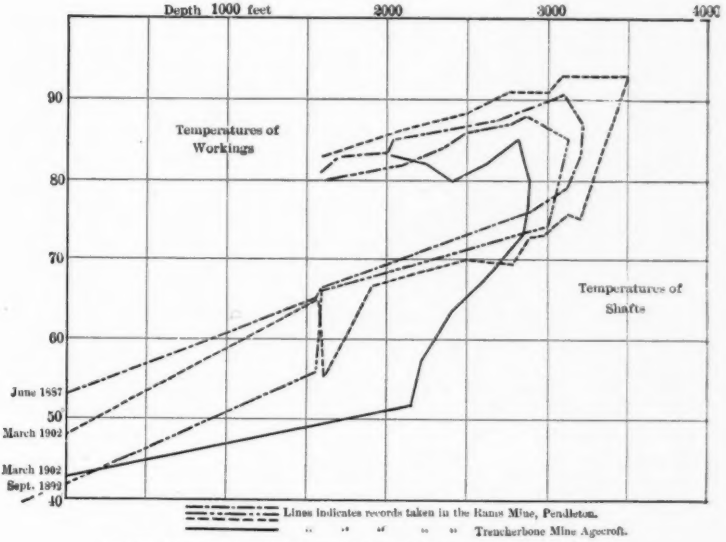


CHART SHEWING UNDERGROUND TEMPERATURE OBSERVATIONS.

perature of the rock was 1 degree for every 55 feet, and at a depth of 2,445 feet, the temperature was 94 degrees. On the other hand, in many sinkings the increase is much less, often about 1 degree in 80 feet, while at Niddrie Colliery, Portobello, the increase is only 1 degree in 105 feet, the temperature at a depth of 2,623 feet being 74 degrees.

The workable limit of temperature depends largely on the dryness of the air. At Pendleton, even where the temperature is 93 degrees, little or no inconvenience is felt from the heat, as the atmosphere is so dry, and it is thought that the workmen will be able to stand even 100 degrees. In the case of a moist atmosphere, however, a much lower temperature will be found insupportable.

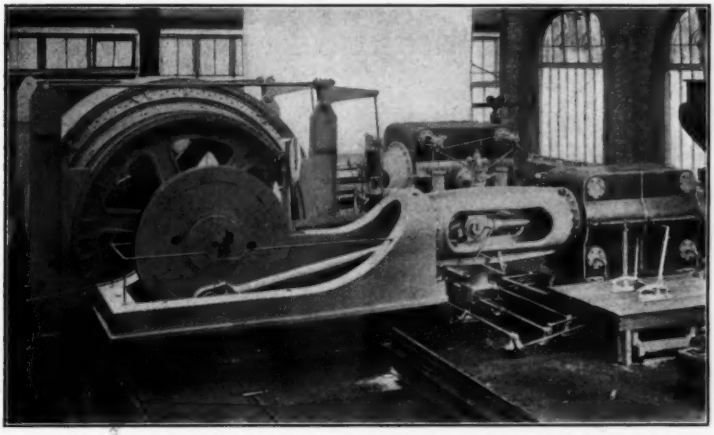
The use of compressed-air machines and drills in the mine is of great value in reducing the heat, and no doubt this will be an important factor in favour of the adoption of compressed air rather than electricity in deep mines. Liquid air has been suggested as a means of artificially cooling the atmosphere in the working places, and may ultimately prove of value. The use of large shafts, 20 feet and upwards in diameter; the construction and upkeep of capacious air-ways: and the maintenance of a thoroughly efficient ventilating current throughout the mine, will, however, best aid the mining engineer in the control of the temperature.

The great pressure due to the increased depth at which minerals are worked at the present day, is in the case of coal mines gradually rendering the old "bord-and-pillar" system of working obsolete. The 70 or 75 per centage of coal left in the form of pillars has to bear the same weight of superincumbent strata as lay upon the original untouched coal seam. When mines were shallower, the pressure was not sufficient to crush the coal excessively, but was generally enough to make it much more easily workable at the second working. Now, however, the increased pressure is proving too much for the pillars that are left, and crushes them so severely as to render the coal unmarketable, or even to lose the mine. In all cases resort is made to the more modern system of "long-wall" working, the system whereby the coal is removed in one working, slice by slice, from a long face or "wall," the roof gradually subsiding on to packing placed to receive it. It speaks volumes for the ingenuity of mining engineers to find that not only does this enable the coal to be got in a marketable condition, but that the very pressure which before crushed the coal to slack is now made to aid in the working of the coal, and that the coal can be got at a cheaper hewing cost in a deep than in a shallow mine.

The consideration of roof and floor is a very important point, as even at a very great depth a seam can be worked without any serious difficulties, provided the roof and floor are of good hard sandstone. Sandstone, too, affords excellent packing for the wastes. In the Niddrie collieries, at a depth of only 1,200 feet, a seam which was overlaid by soft shale was rendered unworkable by the method of bord-and-pillar, as no sooner was an opening made than it began to fill up with the shale from the roof. On the other hand, at a depth of 2,600 feet no particular trouble was experienced in the working of a 5-foot seam by long-wall, the roof and floor being of harder rock.

As a coal mine proceeds to depth, there is more frequent danger from "blow-outs" of the coal. The pressure of the strata, probably assisted by pressure of gas, causes the coal seam suddenly to give way in some weak spot, and several tons of coal and slack are projected out from the face with great violence, sometimes burying one or more unfortunate hewers. These outbursts in some seams occur at a depth of 600 feet, and in others do not take place until after a depth of 3,000 feet has been reached.

Occasionally the engineer is enabled to make use of some natural advantage at his disposal. For instance, in the Rams mine at Pendleton, there is a layer of soft dirt above the seam, which the miner



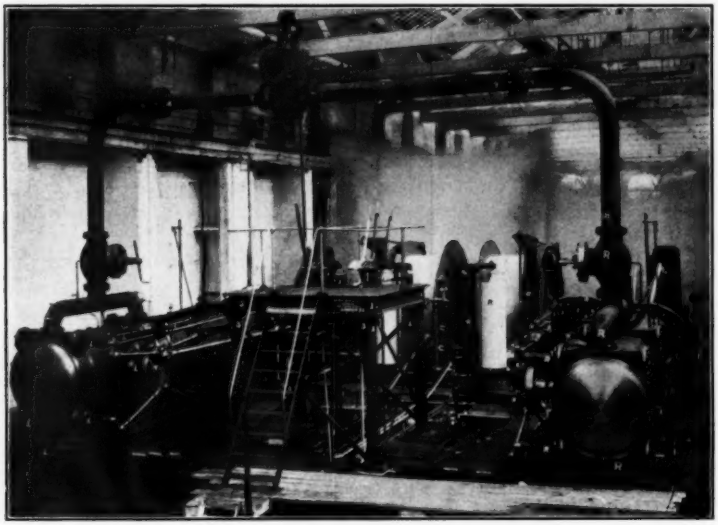
CROSS-COMPOUND WINDING ENGINE AND DRUM FOR THE SHERWOOD COLLIERY CO.
The drum is cylindrical for three revolutions, then conical for two revolutions, and cylindrical for the rest of the wind. Built by Fraser & Chalmers, Ltd.

scrapes out. This relieves the coal from the top pressure, and the bottom pressure forces it up and breaks it off in large pieces, saving the miner this trouble. It is interesting that from this seam at a depth of 3,500 feet, a piece of coal weighing 25 hundred weight was got for the Coronation Procession. When this can be done at 3,500 feet, who shall say where the limit must be put to the depth to which the colliery engineer can penetrate?

In metal mines, where the hanging and foot walls are often very hard rock, pressure does not seem to threaten to be a very serious item. Crumbly rock, and rock that weathers rapidly, is much more difficult to deal with than tough, weather-resisting material. In the Lake Superior district the copper ore is mined at a depth of more than 5,100 feet, and is likely to proceed much deeper, while on the Rand there is every possibility of the gold reef being worked at a depth of 6,000, or even 8,000 feet. In both these cases the hanging and foot walls are of hard rock.

The problem of deep winding affords a special interest to the Midland counties of Great Britain, where there is a probability of the hidden coal seams being worked ultimately to great depth. Professor Redmayne, in an address delivered a short time ago, said that the colliery of the future, by means of three or four shafts, and with a total of 25,000 horse power, will draw from a depth of 4,000 feet a daily output of 12,000 tons.

The great cost of sinking a pair of deep shafts, and of a modern colliery equipment, necessitates a proportionately large output. This must be ensured by rapidity of winding, and the raising of a heavy net load at each trip. The operation of winding may be carried out in a single lift from the pit bottom to the surface, which may be termed single-stage winding; or it may be effected by winding from the bottom to a stage in the middle of the shaft, and from thence to the surface (double-stage winding); or the number of stages may be extended to three, and even more.

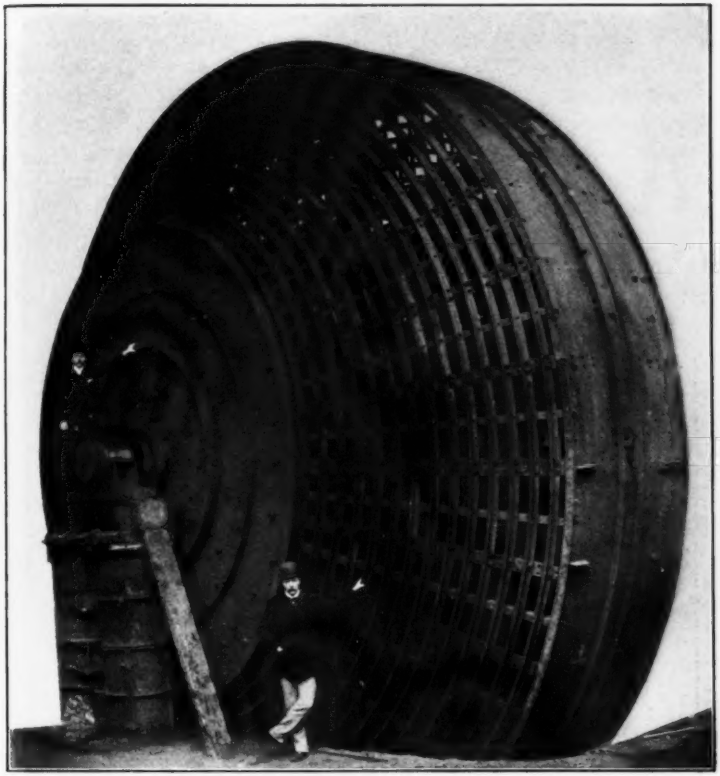


HIGH-PRESSURE HORIZONTAL WINDING ENGINES, FOR WINDING 64 CWT. FROM A DEPTH OF 3,000 FEET.

Cylinders 24½ inches by 6 feet. Average speed 1,500 feet per minute. Built by Robey & Co., Ltd., for the Great Boulder Prop. Gold Mines, West Australia.

In single-stage winding, owing to the great length of rope, the dimensions of the drum are exceedingly difficult to keep within bounds, as either the breadth of the drum and the consequent angling of the rope are excessive, or the diameter of the drum is so great as to cause too much increase in its moment of inertia, besides lowering the piston speed of the engines, and preventing them getting into their stride quickly.

The weight of the rope, owing to its great length, is a serious difficulty, and various methods of balancing this dead weight have been tried. Conical and spiral drums are in great favour, and it is

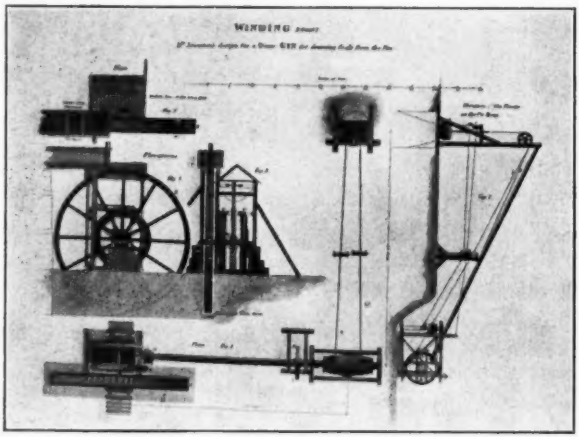


BUILT UP STEEL SPIRAL DRUM, TO WIND 4 TONS NET FROM A DEPTH OF 2,289 FEET. Diameters 18 to 33 feet; shaft 24 inches; weight of drum alone, 80 tons; built by Robert Daglish & Co.

interesting to note how these recall the devices of nearly a hundred years ago. In an ancient mechanical winding apparatus, driven by water power (see next page), a conical drum was designed by Mr. Smeaton, about the year 1810; and in the early days of steam winding, flat ropes or chains were used which coiled upon themselves on a reel, in exactly the same manner as the tape in a tape measure. This latter device served the same end as the spiral drum, but the cost of the ropes was very great. Short sections of these ropes are shewn on page 553. At Shut End colliery, near Kingswinford, a chain winding plant of this type was erected about 1828, and is still in use (see page 553), the depth from which it winds being about 730 feet.

In 1896, an interesting plant was laid down at No. 2 pit, Preussen colliery. This consisted of Mr. Tomson's device of dividing his conical drum into two halves, and mounting each on a separate shaft; by this means avoiding a single shaft of unwieldy proportions, while keeping the diameter of the drum within bounds. (Page 555.)

The difficulty of avoiding excessive angling of the rope, and yet employing an engine and drum of moderate size, when winding from the great depth of 2,700 feet, was overcome by Mr. W. Morgan in a most ingenious manner. The drum, as was natural, had to be built

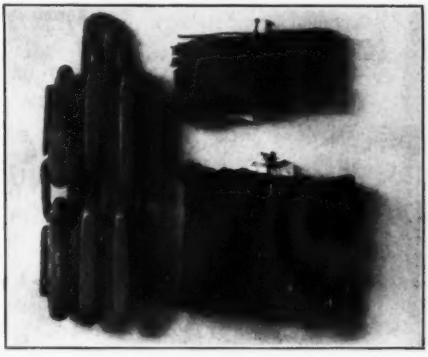


SMEATON'S DESIGN FOR A WATER-POWER WINDING GIN, SHOWING CONICAL DRUM.
From an old drawing.

of unusual length, in order to hold the requisite number of coils of rope. Mr. Morgan mounted both engines and drum on a travelling carriage, which traversed a distance equal to the diameter of the rope, with every revolution of the drum (see Figure 9). Angling of the rope was by this means entirely obviated.

One of the most ingenious attempts, and by no means an abortive one, to solve the problem of deep winding, was that of M. Blanchet in fitting the Hottinguer shaft at Epinac with his pneumatic system of winding. The shaft was intended to attain a depth of 3,300 feet, but owing to the lack of workable coal was stopped at 2,130 feet. M. Blanchet's chief motive for the adoption of this system at Epinac

was to enable the pit to start work immediately on the completion of the first shaft, without waiting for the sinking of the second shaft, and yet to ensure good ventilation. This meant in the case of the Hottinguer pit a saving of five years. It is unfortunate that the fact of no workable coal being found in the shaft gave the plant no opportunity of operating on a large scale. It was sufficient, however, to shew that the system was thoroughly workable, and in spite of the great initial cost, to be expected in an experimental installation of the kind, could be made a practical success.

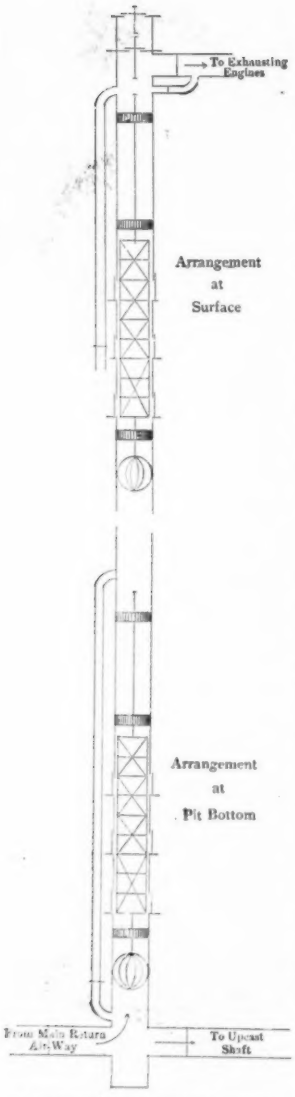


OLD FLAT ROPES AND CHAIN, FORMERLY USED FOR WINDING.

In view of the heat of the deep strata, M. Blanchet decided not to increase this heat by compressing the air in the tube, and so heating the shaft, but to exhaust the air, drawing the load up by suction, which would have a cooling effect on the air going down the shaft. The tube, which was of wrought iron, 63 inches in diameter, in lengths of about 20 feet, was hammered round upon a special mandril, and placed at one side of the shaft. The cage, which has nine decks, and carries over 4½ tons of coal, is slung below two pistons and above a third, as shewn on page 554, while beneath all is a parachute, in case of accident. Three cages can be loaded or unloaded simultaneously, the valves to connect the tube with the exhausting engines or the outer atmosphere being operated by the onsettors and banksmen.

AN OLD COLLIERY, WITH FLAT WINDING CHAINS STILL IN USE.

It is highly probable that we have not seen the last of the pneumatic system of hoisting. Its advantages in connection with deep shafts are



BLANCHET'S PNEUMATIC HOIST.

numerous. The method can be practised with as great facility in mines of enormous depth as in shallow mines, and the winding rope, which in a deep mine is a very expensive item, and a constant drain on the resources of the concern, is entirely dispensed with. A large load can be dealt with at each trip, and the speed of the cages, especially in the descending trip, is almost unlimited. Ventilation is assisted, and the air in the downcast shaft is cooled (if exhausting engines are used)—a great gain to the engineer who is anxious to reduce the temperature of the working places in his mine. Last, but not least in importance, repairs can be carried out in the shaft without interfering with the raising of the mineral.

Taper ropes are being considered by mining engineers, as a means of lessening the masses to be set in motion by the engines, but their cost is very great. One of the first applications of the taper rope was made at Przibram, about 22 years ago, in a shaft 3,900 feet in depth. It is said that the ropes lasted 3½ years, making 100,000 trips a year. It is more usual and less expensive to have a long winding rope made in lengths of 500 feet, or more, joined together, the section of each length being less than the one above it. This answers the same purpose as a taper rope, and the average weight per unit length is not much greater.

The efficient balancing of the winding rope makes greatly for economy in engine and boiler power, as the static load throughout the wind is

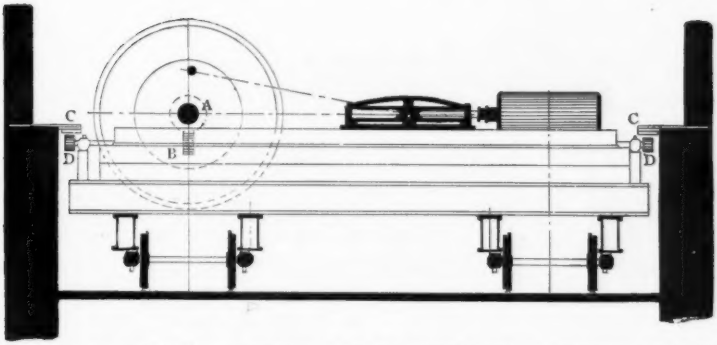
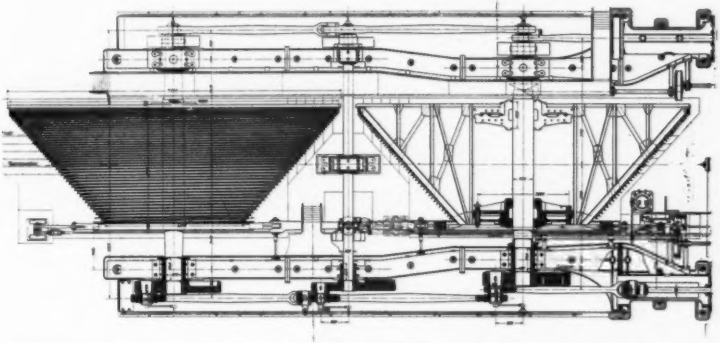


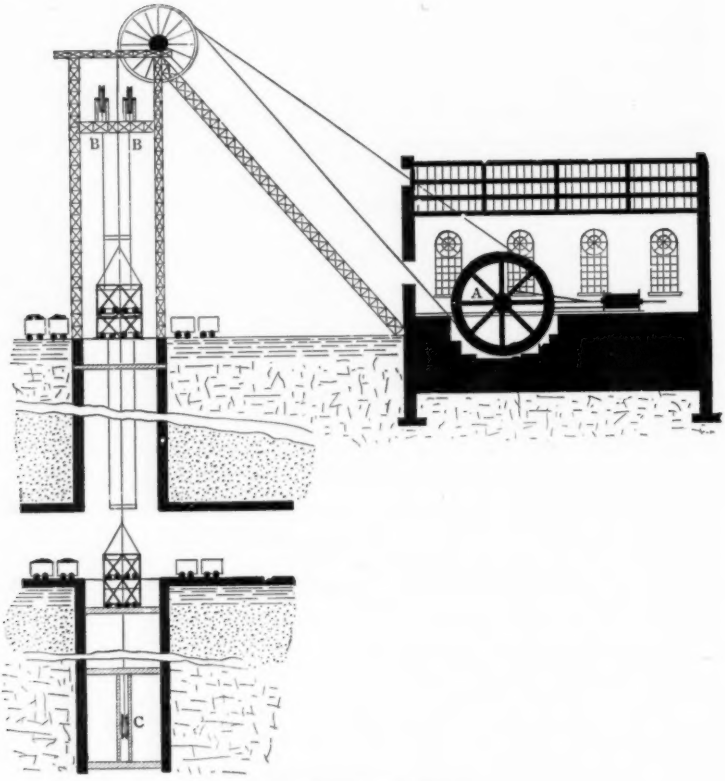
DIAGRAM OF MORGAN'S TRAVERSING WINDING ENGINE FOR PREVENTING ANGLING OF ROPE.

constant, and equal to the weight of mineral raised. The best known modern method of balancing the rope is the Koepe, introduced by Mr. Koepe at Hanover Colliery, Westphalia, which employs a tail rope under the cages. The winding drum is dispensed with, its place being taken simply by a driving sheave, about which the rope passes. Two sheaves are used in the Whiting system, which is a development of the Koepe, the principle being similar. The comparative lightness of the driving sheaves, and the absence of heavy coils of rope revolving with the drum, give a correspondingly diminished moment of inertia, with the result that engines of less power may be used.

The Whiting hoist, which is used at the Red Jacket shaft of the Calumet and Hecla mine, Lake Superior, at Kimberley, and at some



TOMSON'S METHOD OF DIVIDING A CONICAL DRUM TO PREVENT UNWIELDY SIZE OF DRUM SHAFT.



KOEPE SYSTEM OF WINDING.

A, winding sheave, about which the main rope takes a half turn; B B, auxiliary ropes to prevent damage in case main rope breaks; C, pulley in sump about which tail rope passes.

gold mines on the Rand, has an ingenious arrangement by means of which it can wind from different depths. At the Calumet and Hecla mine, the difference between the depths from which the engine can wind is more than 1,200 feet. (See page 557.)

The results obtained by simply attaching a tail rope under the cages, and winding with a drum in the usual way, are well worth the attention of engineers. In one case, the addition of a tail rope in a pit 1,260 feet deep reduced the effective horse power required by 11 per cent.

There are several ingenious methods in use of balancing the winding rope, other than by attaching a tail rope. The method in use at Camphausen, where the main shaft is nearly 2,000 feet in depth, requires an auxiliary shaft of about 250 feet. A diagram explanatory

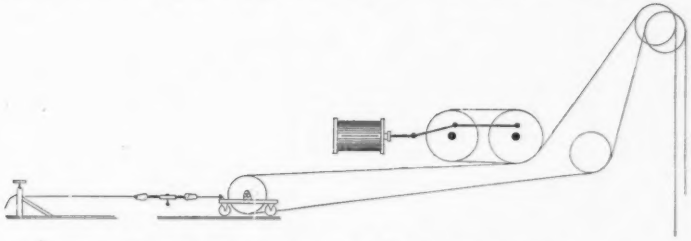
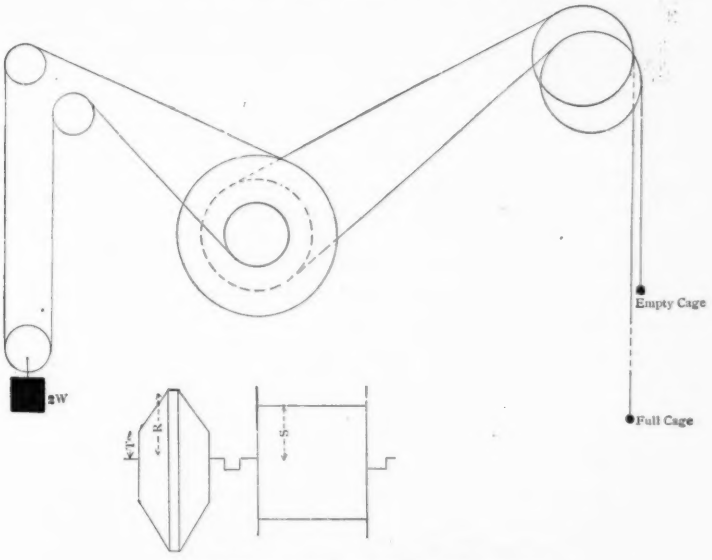
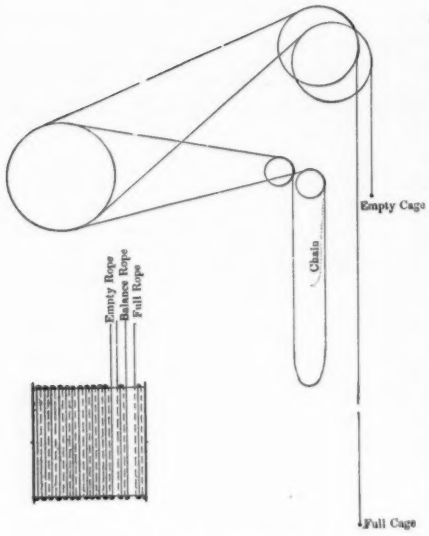


DIAGRAM EXPLANATORY OF WHITING HOIST SYSTEM.



BALANCING THE ROPE, CAMPHAUSEN METHOD.

of this device is shewn just above. A supplementary spiral drum is mounted on the main drum shaft, and the rope from which the balance weight in the auxiliary shaft is suspended unwinds itself on the descending side, and winds itself at the same time on the ascending side. Thus the arrangement is "differential."



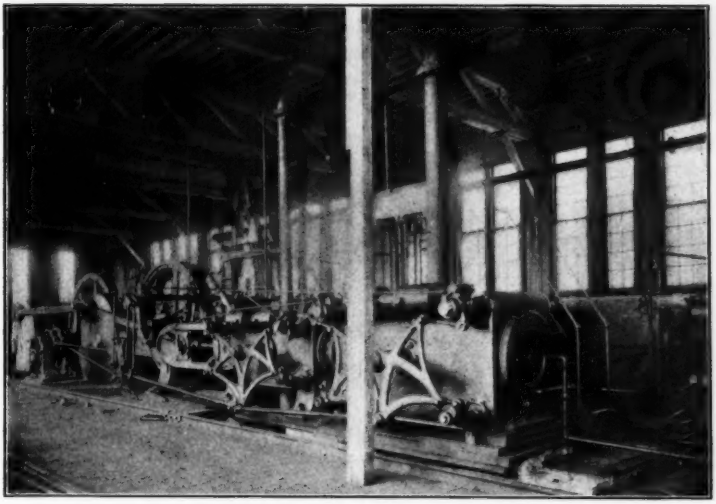
BALANCING THE ROPE, DESPRÉS' METHOD.

If R and r are radii of the spiral drum, and s the radius of the main winding drum, and 2W and w the weights of the balance weight, and the unbalanced rope respectively, then for equilibrium of rope at commencement of wind, $(R-r)\ W = sw$.

In the method invented by M. André Després, a cylidrical drum is used, and the auxiliary rope to which a balancing chain is attached is given one or two turns round the drum, its place on the drum being between the full and empty ropes. This rope (endless) passes down a special compartment of the shaft to half the depth of the shaft, and comes back to the drum. A chain is slung on a pivot a quarter of the way down the shaft, and is fixed to the auxiliary rope in such a way that the other end of the chain is at the top of the shaft at the beginning and end of each wind. This of course assists the engine at the beginning, and the brakes at the end of each trip.

Although the balancing of the static load is an excellent thing, it is improbable that engineers will rest until the balance of the dynamic load is effected. The increase of power required from the engine during the acceleration period is often as much as 50 per cent. above the average power required for the whole wind, and when the period of rest is taken into account the discrepancy is still greater.

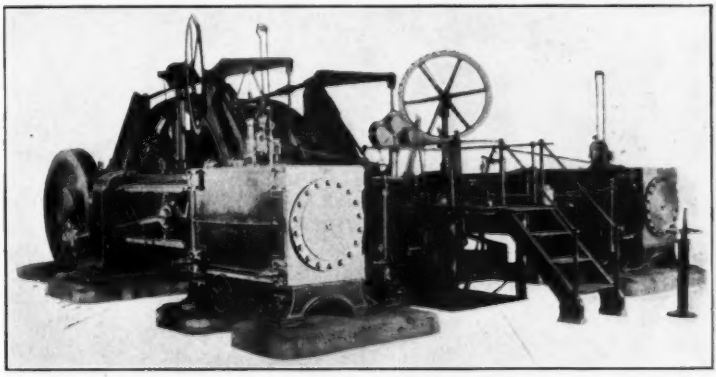
To take an extreme case, suppose it to be required to raise 100 tons an hour from a depth of 4,000 feet, with unbalanced taper ropes, and a cylindrical drum, at a single lift. Then if the initial acceleration were 4½ foot-second units, the effective horse power required during the acceleration period would be about 2,000, while if averaged over the whole hour it would only be 600. The reason of the discrepancy is that acceleration must be created not only in the load, but also in the masses of the drum, cranks, pit-head pulleys, and ropes,



WHITING HOIST, THE TYPE LARGELY USED IN THE MINES OF THE RAND.
Built by the Allis-Chalmers Co., Chicago.

and at the end of each run the kinetic energy stored in these must be destroyed, either by brake power, or by turning the steam against them, or as is usually the case, by both.

It is evident that if the energy of a steadily running engine were stored up in such a way that the store could be drawn upon as re-

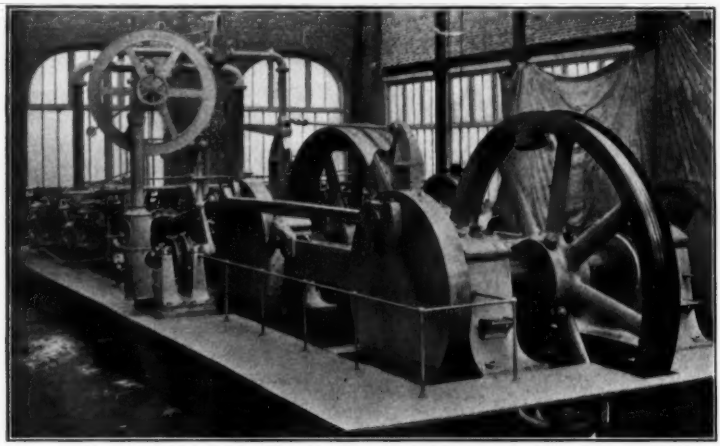


FIRST-MOTION WINDING ENGINE, WITH DOUBLE REELS.
Rocky Mountain type, for flat ropes; drums secured to shaft by heavy band-friction clutches and controlled by powerful post brakes of gravity type. Wellman-Seaver-Morgan Co.

quired, the solution of the problem would be within sight. It may come by means of electrical, hydraulic, or pneumatic agency.

There is a strong tendency at the present day to "electrify" large works by means of a central generating plant which supplies all the machinery with power. Professor Redmayne states that in his opinion, the great mining concerns of the future will be supplied with power from a central generating plant, driven by "producer-gas" engines, and that possibly three or four different mining companies will join forces to build a common generating plant which shall supply them all. The power thus derived will drive all the machinery, including winding, hauling, drilling and undercutting, screening, washing, etc., and will also light the mines. The economy of power thus attained will probably afford the solution of the deep-winding problem.

Hydraulic accumulation of power does not seem to lend itself to the equable expenditure of power throughout the operation of winding, excepting perhaps as a balance weight, but the pneumatic system, introduced by M. Blanchet, will apparently call for more than passing notice. Whether compressing or exhausting, there is no reason why the engines should not be kept running steadily through the whole working day; while for ease of application to mines of enormous depth, it is beyond comparison with rope-winding systems.



WHITING HOIST, BUILT BY FRASER & CHALMERS, LTD.

Showing the winding end. The steam end is shown on the preceding page.

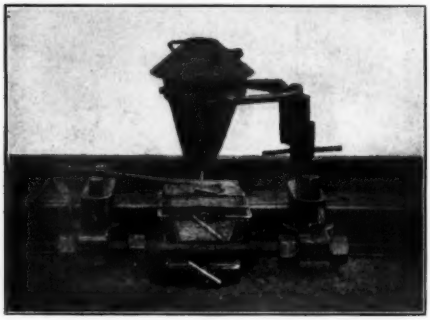
WELDING TRACK AT DRESDEN, SHOWING THE CLAMPS AND MOULDS AND CRUCIBLE READY TO IGNITE AND POUR.

MECHANICAL AND METALLURGIC APPLICATIONS OF ALUMINOTHERMICS.

By Emile Guarini.

The process described in the following pages, as said in the conclusion of the article, is one which is capable of ministering greatly to the convenience of mechanical and structural work—especially repair work. In that respect it has been thought worthy the attention of the largest engineering societies, and in the same spirit it is described here.—THE EDITORS.

TO make cast iron anywhere at will, without fuel and with the minimum of equipment; to cast all kinds of metals with the aid only of a match; to make the metals serve for their own fusion—these possibilities are surely by no means commonplace, and the opportunities for practical application they afford are many. And yet this is scarcely an over-dramatic description of the results attained by "aluminothermics." The reaction upon which they are based, dis-



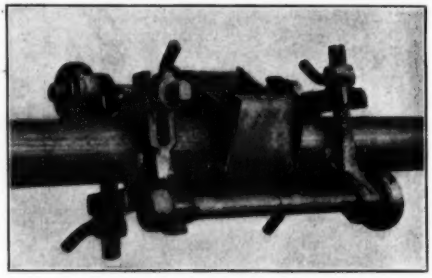
COMPLETE OUTFIT FOR RAIL MOULD.

covered by Dr. Goldschmidt, of Essen, is as follows: if a mixture of pulverized aluminium and a metallic oxide be ignited at a single point, combustion proceeds without further supply of external heat, without any combination with the atmospheric oxygen, and with the development of a temperature estimated at 3,000 degrees centigrade. The reaction reduces the oxide, yielding the metal pure and free from carbon, and leaves a scoria of aluminium oxide, or artificial corundum.

In industrial practice the oxide of iron is naturally the one most often used. The mixture of aluminium and ferric oxide has been given the commercial name "thermite," and for convenience this term is employed in the following brief description.

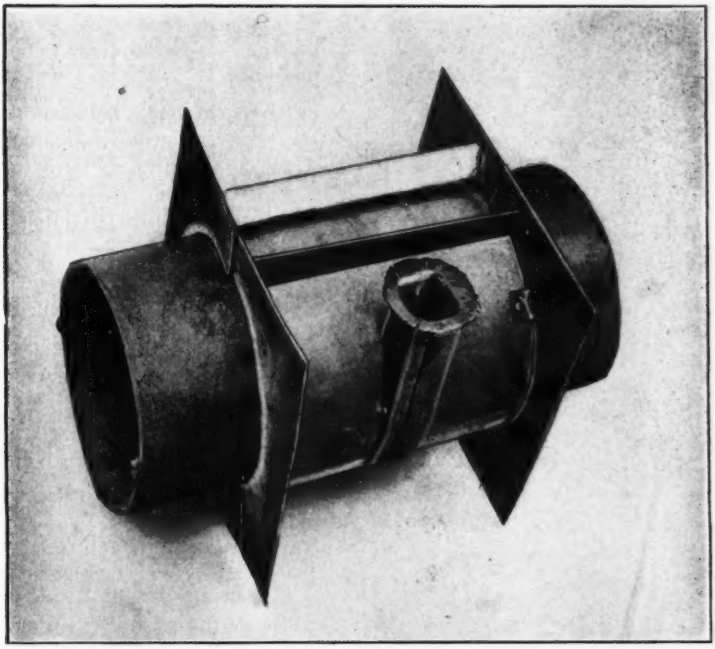
Thermite on combustion yields a soft homogeneous iron, which on account of the high temperature to which it is raised has the property, when poured upon a metal part which is to be repaired, of softening the surface over which it flows and uniting intimately with it.

The reaction is carried on in special crucibles made of sheet iron lined with magnesia. The corundum may be decanted, or the iron poured from beneath by unstopping a hole prepared in advance in the bottom of a so-called "automatic" crucible of conical form. To light the thermite, the crucible must first be thoroughly dried. Into it are then poured a few teaspoonfuls or many kilogrammes of thermite, according to the requirements of the operation to be performed. Upon the top of this is then placed a small pile of a firing powder made of aluminium and peroxide of barium. The operator, hav-



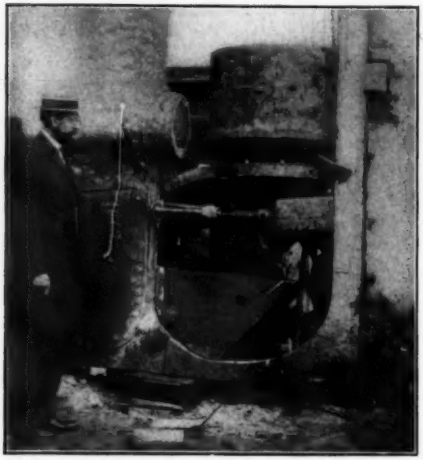
WELD MOULD FOR HORIZONTAL TUBES.

ing put on a pair of smoked glasses, then fires the powder by means of a match fuse or a bar of iron heated red-hot. The reaction of the thermite begins at once and is complete in less than a minute. More of the reagent may be added during the reaction, if needed. The iron produced may be improved by adding to the thermite about 0.3 or even 0.5 per cent of ferro-silicon. Manganese or titanium may also be added. The addition of 100 to 250 grammes of pig iron per kilogramme of thermite yields a hard, fine-grained, and very malleable steel. With a large increase in the amount of iron added, the resultant product is a hard, malleable tool steel. Titanium may of course be added to this mixture.



MOULD FOR BRAZING TUBES OF LARGE CALIBRE.

Besides iron, the process may be used for the production of many alloys and other metals, free from carbon, a result not heretofore attained even by the electric furnace. Among the more important of these products are manganese, chromium, and the alloys ferro-titanium, ferro-boron, ferro-vanadium, mangano-titanium, etc. Finally, the corundum which is produced finds application for use in making



REPAIRING STERNPOST OF THE SEBENICO, TRIESTE, JUNE, 1903.

Fracture 120 by 200 mm. Engraving shows longitudinal section of mould box, and crucible in place.

REPAIRING THE STERNPOST OF THE SEBENICO.

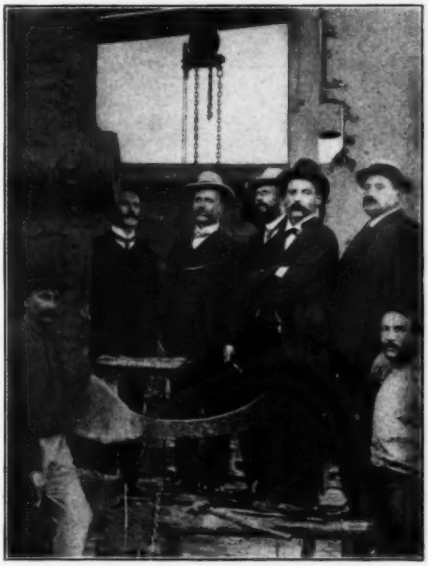
The moment of pouring.

grindstones, as a grinding powder, etc.

It is not hard to see the many possible industrial applications for a process which thus permits the production of temperatures so high, in so short a time and with so little apparatus. One of the most important is the welding of iron and steel pipes or tubes, for which all the necessary appliances are seen in the illustration on page 562. The faces to be welded are dressed and fitted to one another, and then pressed together by a suitable device. The joint is then surrounded by a mould which varies in form according as the tubes are large or small in size, vertical or horizontal in position. (Page 563.) Into this mould is poured the incandescent mass produced from the thermite. The heat which it imparts raises the metal of the tubes to the welding temperature. This operation is particularly valuable in the making of bends or coils, in which defects often develop after the bending in completed, and the

otherwise finished piece is on that account rejected. The defective part can now be cut out and replaced by a sound section welded in with thermite. The method can be adapted also to the formation of bosses for taps or branches. (Page 566.)

Equally important is the application to the welding of rails, which may be accomplished in shorter time than is required for making a good joint with bolts and fish plates. Page 562 shows the entire necessary outfit. Besides its lower cost, this process has some decided advantages over the bolted-joint construction. In addition to an actual welding of the rails end to end, there is obtained a kind of splint of soft malleable iron forming an integral body with the foot of the rail. The gain in point of better return circuit for the current in the case of electric railways is apparent. Further, it gives a continuous rail, free from jolt-producing joints, and thus ensures longer life both of the rail and rolling stock.

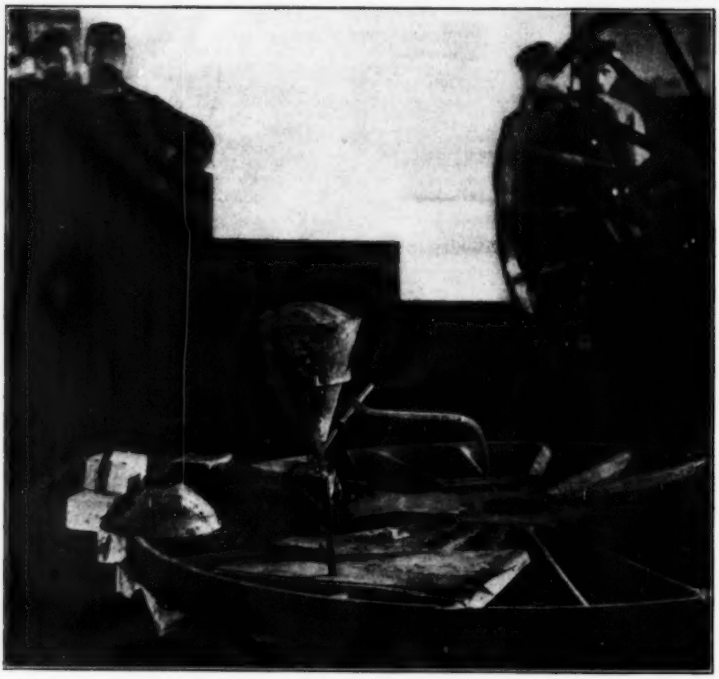


REPAIRING THE STERNPOST OF THE SEBENICO.
The weld completed.

In like manner shafts may be welded; defective, worn, or broken machine parts, whether of cast iron, steel, or wrought iron, may be repaired; bearings of rolls may be welded; gear teeth may be mended or replaced—in fact, welding or casting of steel parts be accomplished anywhere and instantly.

The method is applicable also to intercalary casting. Striking evidence of the intimate union effected is afforded by the examination of an acid-etched section of 140-millimetre bars thus welded. On page 567 are shown castings of thermite iron incorporated with boiler plate of 20 millimetres thickness. The pieces have been cut half through, fractured, and then etched with acid to bring out the weld. Finally, the process permits the welding of cast iron to steel, and

REPAIRS OF WROUGHT-IRON PIPE BENDS, ABOUT 8 INCHES AND 4 INCHES DIAMETER.



REPAIRING LOCOMOTIVE DRIVING WHEEL, AUSTRIAN STATE RAILWAYS.

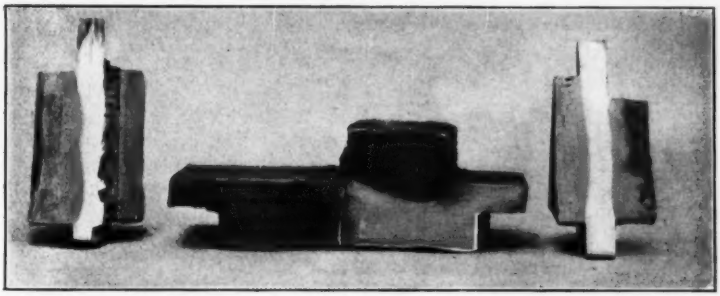
vice versa. And, especially with the so-called "automatic" process, it does not require a highly skilled labour to apply it. One or two workmen are sufficient in the majority of cases.

CONNECTING ROD REPAIRED WITH THERMITE.

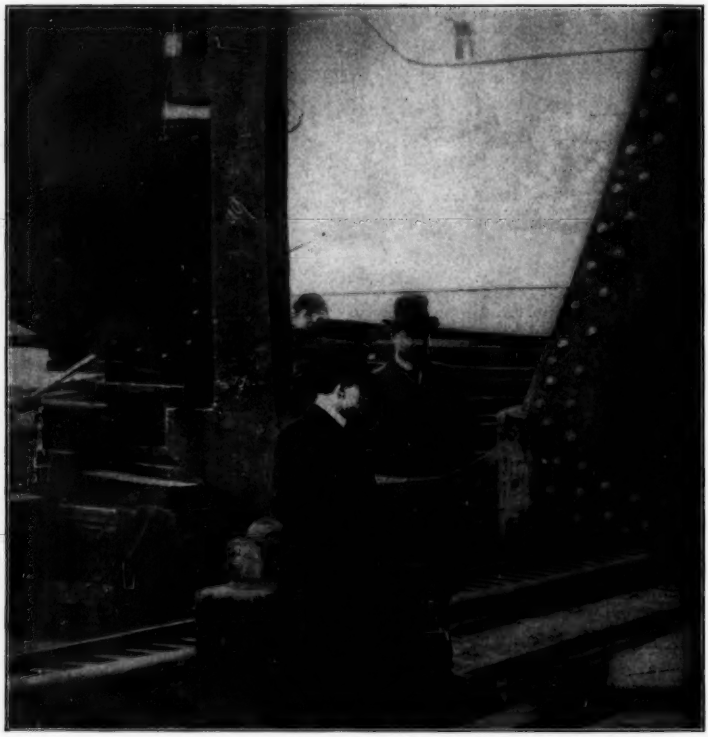
It is needless to list or to dwell upon the many cases to which the exothermic process and reagents may be applied. They will suggest themselves on a moment's thought of the contingencies arising constantly in the workshop, the factory, the steamship—indeed, wherever machinery is used or metallurgical processes are carried on.

The process is not "revolutionary" in the larger sense, but belongs to the order of those discoveries and inventions which, by their commanding convenience of application, greatly increase the ease of mechanical operations, or even enable entirely new operations, and so minister to the economy of manufacture and production and to the progress of engineering industry.

The possibilty of repairing large machine or structural parts, suggested by some of the illustrations in the preceding pages, without dismantling the whole construction or taking the broken piece out of its place, alone implies great savings of time and labour. Thus the fractured crank shaft of a Rhine steamer, although 10 inches in diameter, was repaired between five o'clock in the evening and



ACID-ETCHED SECTIONS OF WELDS OF CAST IRON ON 20-MILLIMETRE BOILER PLATE.



REPAIR OF BROKEN STERNPOST OF STEAMER "SEVILLA," 9,000 TONS, HAMBURG, NOV., 1902.

Section 200 by 500 millimetres. 300 kilogrammes of thermite used.

ten o'clock the next morning. Two and a half hundredweight of thermite were used on the job. The Hamburg-American liner Sevilla, the broken sternpost of which was welded in place as shown on this page, has repeatedly made the voyage between Hamburg and Argentina and is registered full class at Lloyds. The method, in short, carries the repair operations to the break, with the utmost ease of transport and range of adaptation, instead of requiring the broken part to be brought to the repair shop.

CUTTING SPEEDS AND FEEDS WITH THE NEW TOOL STEELS.

By Oberlin Smith.

IN THE ENGINEERING MAGAZINE for April last I considered the subject of the new high-speed cutting tools and their effect on machinery manufacture in general. This was followed by articles in the *American Machinist*, pointing out more particularly the mechanical changes that would have to be made in the machines for doing this cutting with the new-found alacrity incident to the new conditions. The purpose in undertaking this short article was to give some further records of actual high-speed work.

Unfortunately, a recent fire, which entirely destroyed the Machine Works with which I am connected, cut short the line of experimenting that I was following, leaving but one little record as given below. A curious incident connected with this fire happened in the starting up of a certain 62-inch vertical boring mill, after the ruins of the building and its own countershaft, which had fallen upon it, were cleared away. A heavy 40-inch flywheel was in process of being turned the afternoon before the fire, with a high-speed steel tool taking a heavy roughing cut down its face. By what seemed almost a miracle, the machine was injured but little and worked perfectly after starting in motion, neither the wheel nor the tool being unset or altered in position. The turning proceeded as usual, the remainder of the cut being taken from the face of the wheel without disturbing anything. The tool, which must have been very hot, appeared to be in perfect order and both machine and tool have been doing work ever since on similar flywheels, running at a speed of about 50 feet per minute.

The unfinished record of experiments above referred to shows first a new brand of high-priced steel, the vendor of which did not know whether or not he could claim it to be of the high-speed order. This tool ran about four minutes at 28 feet per minute, before the edge was spoiled. The second experiment was with a self-hardening steel sold by vendors of composite tools (those in which the cutter is inserted and held by a set-screw) as of the most suitable quality for their purpose. It ran at a speed of 63 feet per minute for about a minute-and-a-half, when the point gave out entirely. The third experiment was with one of the new high-speed steels, which remained perfectly good

after running 117 feet per minute for several minutes. The material worked was a medium-hard steel shaft forging, and the chip was something over 1/16-inch square.

In the absence of recent data of personal work, it may be of interest to here give a compilation of some of the work being done by certain steel-makers and other experimenters who are developing this era-making subject. This will at least give some indication in regard to the present state of the art—the rapidly changing and developing art of metal cutting.

A friend who is eminent in machine-tool design writes that he has found no economy in trying to cut cast iron faster than 50 feet per minute. He says, however, that this limitation may be due to the lack of rigidity in the lathe and in the work being operated upon therein. He remarks further that the reason he has no definite results to report is not because he has not had samples and experience, but because he has not machines that have sufficient strength and speed.

A prominent company making one of the first-class brands of high-speed tool steel reports experiments from some of its customers as follows:—Used a roughing cut on soft steel at 100 to 120 feet per minute, and finishing cut 165 to 200 feet. Turned a cast-iron drum 12 inches diameter by 42 inches long, with a roughing cut at 85 feet per minute, 1/8-inch feed, 3/4-inch depth of cut; ran a finishing cut with the same feed, at 185 feet per minute, the tool remaining in good condition in both cases.

Turned a 68-inch Krupp locomotive tire, feed 1/8-inch, speed 16 feet per minute; the tool ran all across the face of the tire without injury, while a self-hardening tool of best quality gave out after four revolutions. Also bored a medium-hard locomotive tire with feed of 1/8-inch and depth of cut 1/4-inch at 28 feet per minute. Ran a cut across a cast-iron pulley 72 inches wide at 60 feet per minute, and the tool was undamaged.

Another prominent maker speaks of shipping three-and-one-half tons of tool steel to one customer after he had given it a working trial. Experiments with the same steel at one of the leading tool-making shops in the United States showed results as follows:—On 2-inch diameter .30-carbon machinery steel, using a cutting speed of 261 feet per minute, with a feed of 1/10 inch, a depth of 1/10 inch and a travel of 15 inches, the tool came out slightly dull but good for more work. During the last half of this experiment the tool and chips were both red-hot, in a comfortably light room. In another experiment at the same place, with a shaft 1 1/2 inches diameter, of the same steel, the speed was 194 fret per minute with the feed and depth the same, but

with a travel of 18 inches. The tool was red-hot the last half of the time, but held a perfect edge, not needing regrinding.

In regard to another very well-known steel which has been sold to many prominent manufacturers, in one case over 20 tons in a lot, the makers speak of speeds as high as 232 feet per minute, with a feed of ⅛ inch and a cut of ¼ inch depth, the materials being cast-iron. They tell also of 247 feet per minute, with the same feed and cut, on .40-carbon-steel. We are told of twist drills of this last-named steel running at 128 revolutions per minute, drilling about 600 holes in hard steel castings ⅝ inch thick. This was in competition with regular standard twist drills, which could run but 80 revolutions and bore but 5 holes before entirely giving out. Another drill ran at 480 revolutions, drilling holes in annealed high-speed steel, of its own kind, 1½ inches deep in a minute, without showing any wear.

Another record relative to one of the steels previously mentioned, which was tempered in lead or warm oil, shows speeds from 125 to 142 feet per minute on cast-iron, with 1/16-inch feed and 3/16-inch depth of cut. These continued in some cases for 20 minutes and more without damage to the edge of the tool.

It will be noticed that the chief merit so far claimed for the new tools is the attainment of high speeds, and that the work with them has usually been done in lathes, planers etc., where an ordinary forged and rough-ground tool, with one cutting edge, was employed. In many cases it was necessary to heat the edge of the tool almost to the melting point in the process of hardening; the edge thus became rough and rounded off, requiring grinding afterwards. There seemed, therefore, to be limitations which would rule out such fine tools as milling cutters, reamers, taps and dies, etc., because of the spoiling of the numerous accurate and highly finished cutting edges which, upon any one tool, must maintain their exact relation to one another.

Recently, however, many experiments have been made in producing twist drills, cutters, reamers, taps and dies, and this with unexpected success. The composition of the steel and the methods of hardening have been adapted to these special purposes. In this connection there are records, set forth by responsible steel makers, of threading about 20,000 1-inch track bolts without grinding the teeth of the dies, against only 7,500 bolts cut with dies made from regular steel; also of pointing, with high-speed cutters, ⅝-inch car bolts in lots of 22,000, against 4,000 worked with regular steel tools, before sharpening was needed. We hear again of certain cutting tools working 150 pieces per day for 90 days without grinding, against similar cutters of regular tool steel which did but 50 per day, grinding every 6 hours.

Another recent application of the new steels is for punches and dies, where the matter of speed would not seem to be a factor in the case, but where the steel makers claim a great advantage in durability. One record shows the punching of 56,000 holes in ⅜-inch thick metal, against 6,000 with punches made of regular tool steel. We are told of still another case where 1-inch thick hexagon nuts were punched cold at the rate of 40 holes per minute with 29-hours durability, against less than 4-hours life with punches of regular tool steel.

We hear also of punches in pneumatic riveters heading ⅞-inch rivets continuously for more than seven weeks without repairing. These tools last in some cases thirty times as long as those made from the best quality of carbon steel.

For sufficient reasons no manufacturer's names have been given in connection with the above information.* They are however responsible concerns whose statements there is no reason to doubt. They and others are constantly striving to improve their product, and there are already in the United States half-a-dozen or more makers who are offering in open market high-speed steels of excellent quality and of grades to suit a variety of purposes. The price, moreover, is reasonable, considering the comparative value of such a time saver. In general the figures will run from 50 to 75 cents per pound, with a tendency to become lower. Such prices, of course, amount to a good deal in the aggregate when large sized tools are forged solid in the old-fashioned way. In such case the greater part of the material is, of course, wasted in the heavy shank of the tool where inferior metal would do just as well. It has been feared that composite tools, made in the usual way with iron sockets carrying inserted cutters consisting of short pieces of square bar-steel, say ¼ inch to ¾ inch square, would not work as well as would forged tools, on account of not carrying away the heat so rapidly. In some experiments made by me, however, there seemed to be no difficulty in this respect. The composite tools do good work and cost much less in the long run.

I do not know of any definite experiments which have been made on other metals than iron and steel, as for example on brass, copper, and other soft metals, or upon wood, leather, etc. One vendor of high-speed machinery speaks of 150 to 200 feet per minute for brass, but this, of course, does not seem very attractive after reading about similar speeds for steel and cast iron. It is to be hoped that definite experiments may be made with a variety of other materials, with a view of obtaining very high speeds, and proper records may be published.

* Further information will be gladly supplied to those interested, either by the author of the article or by the Editors.

It is probable that the speed figures above, given by various steel makers, are somewhat optimistic, although doubtless correctly stated for the particular experiments cited. In looking over some recently published records in the technical newspapers, more conservative figures on the average are found. Some writers state that the speed limits for cast iron are from 45 to 70 feet per minute. It seems certain that this material is very irregular in its behavior, and that its homegeneity and nearly uniform hardness cannot be depended upon.

The speed per minute at which any material can be cut depends a good deal, after all, upon the *size of the chip*, and no experiments can be trusted to show positive results without the conditions regarding feed and depth of cut entering as important factors into the efficiency of the process of rapid cutting. In a very interesting paper recently read before the American Society of Mechanical Engineers by Mr. Carl G. Barth, he describes the variables that enter into the problem of determining the most economical labor. These he enumerates thus:

I. The size and shape of the tools to be used.
II. The use or not of a cooling agent on the tool.
III. The number of tools to be used at the same time.
IV. The length of time the tools are required to stand up to the work (LIFE OF TOOL).
V. The hardness of the material to be turned (CLASS NUMBER).
VI. The diameter of this material or work.
VII. The depth of the cut to be taken.
VIII. The feed to be used.
IX. The cutting speed.
X. The cutting pressure on the tool.
XI. The speed combination to be used to give at the same time the proper cutting speed and the pressure required to take the cut.
XII. The stiffness of the work.

Then he goes on to describe certain ingenious slide rules which have been contrived for determining mechanically the various problems entering into the question of how much solid material can be turned into chips in a given time. Mr. Barth has been an earnest experimenter in supplementing the great work done by Mr. Fred. W. Taylor in reforming shop management and he has systematically manufactured a great many tons of chips.

There have been several other investigators in this line, including of course the earlier work of those persevering missionaries Mr. Taylor and Mr. White, who are the original inventors of the high-speed steels, and who should certainly have the high honor of being the pioneers in this wonderful change which has startled the mechanical world and inaugurated a new era in machine-shop processes—its birth being practically coincident with the dawn of this to-be marvelous Twen-

tieth Century. Much good work has also been done in collaboration, by Mr. Kern Dodge and Mr. Charles Day.

Of the peculiar composition of the various high-speed steels now offered in the market little is known by the general public, and doubtless some of the ingredients, as well as the processes used, are kept entirely secret. In general, the material is known as tungsten steel—in contradistinction to the old-fashioned carbon steels. In one patent upon a certain brand the proportion of tungsten is given as from 15 per cent. to 30 per cent., with from 1 per cent. to 3 per cent. of chromium. It is probable, however, that in many of the mixtures manganese, nickel, silicon, and molybdenum are also factors to a certain extent.

A summing up of this interesting subject will show rapidly changing conditions, owing to the frequent discoveries and improvements that are being made in the manufacture of the steel itself, as well as in the methods of applying and using it. The new metal has qualities which marvelously exceed anything that could have been expected, even as late as two or three years ago. Its greatest handicap, is the lack of proper machine tools as an environment in which to follow its vocation. The machine-tool makers, however, are beginning to awaken to the importance of increasing enormously the weight and strength of their machines, as well as of the adaptation of their moving parts to much higher speeds than before. They are also beginning to realize that there must be a better gradation of speeds than is given by the old cone pulleys and back gearing of our lathes and of our boring, drilling, and milling machines. The new conditions demand not only a greater number of speeds properly graded, but also quick and easy methods of changing from one to the other. Such convenience and rapidity certainly cannot be attained by pulling stiff and greasy belts from one pulley to another. The object is beautifully accomplished, however, by the various new contrivances for electrical control, especially where arranged with one of the so-called multiple-voltage systems. A convenient control, as well as various other requisities in cheap and efficient machine-shop equipment, call loudly for a system of absolutely individual electrical driving, each machine being a unit that can stand any where upon the floor, in any position, and that can be easily moved from place to place. There should be no connections to the building except a few wires, and an absolutely free space overhead for cranes to handle quickly any piece of work to be put into a machine. The machines themselves can then be moved quickly from place to place as the particular working of the shop may from time to time show the necessity for a change of grouping.

EDITORIAL COMMENT

LOOKING over the world of engineering in the spirit of retrospect and forecast suggested by the season, one is tempted to wild fancy—or to anxious question—as to the world of the Twenty-first Century. It is barely a century and a quarter since Watt brought out his steam engine, and the whole of this short time has been crowded with fast-following, bewildering, and wonder-working discoveries. Will progress continue at the same, or even an increasing, rate? Probably not—or rather, probably the progress will be of another kind, and will lie in the perfection, the full application, and the mutual adjustment of the great agencies lately brought into use. It will be progress toward the utmost of economy and the utmost of harmony. The age of discovery will be followed by an "Age of Organization."

When James Watt invented the condensing steam engine in 1769 he revolutionized industry. It would require a monster catalogue to illustrate and describe the many types of steam engines that have been evolved since that epoch-making invention, and no one but a skilled statistician could accurately estimate the number of able-bodied workmen whose labor would be necessary to the wealth-creating, productive work that the steam engine is at present doing daily. Indeed, it would be an expression of a mathematical ratio only—not an interchangeable equivalent. The steam engine manifestly does things no manual power could do—opens possibilities of production and further employment which would remain forever closed to mere manual effort.

Watt's idea wrought the revolution. For every steam engine employed since Watt's time represents a special—an up-to-date—adaptation of the original and revolutionary idea. Newcomen's primitive steam engine for mine pumping had been at work for many years; but following closely upon Watt's invention of that which has become the prime mover of the modern industrial world, came Arkwright with the spinning frame, Cartwright with the power loom, Whitney with the cotton gin, Cort with the puddling furnace and the rolling mill, Fulton with the steamboat, Stephenson with the locomotive, and Maudslay with machine tools. Then Faraday and Gramme opened the way for all modern electrical machinery; Morse proved the practicability of the telegraph; Howe introduced the sewing machine; Bessemer and Siemens made steel making on a large scale immensely profitable; and McCormick, with his reaper and mower, applied the same labor-saving principles to agricultural industry.

* * *

JAMES WATT foresaw, with a clearness of vision which busy men now rarely appreciate, that the steam engine was a labor-saving machine which, though it might first supplant, would soon supplement labor throughout all lines of productive industry and ultimately open boundless wholly new fields for higher-class and better paid labor, to the infinite advantage of both employers and their workmen.

But the engine offered a surplus of power possibilities for which there was but limited employment until Arkwright with his spinning machinery founded the factory system; the power-driven spinning frame, in turn, overwhelmed the industry with more yarn than the hand weavers could use; then came Cartwright with the power loom; and when the textile manufactures, now mechanically operated throughout, demanded more cotton than the hand pickers could supply, Whitney with the cotton gin extended the field of the machine one stage further. The first great step taken, invention fostered invention. And in every case the result was the same—a temporary disturbance, attended with bitter and violent opposition and outbreaks on the part of labor, but ultimately a great and permanent rise in the status and the pay of the workman, and eager work for thousands where one had been employed before.

* * *

And now, within a very few years, a new factor has entered into the system—the factor of definite co-ordination between the actuating power and the producing machine. Call it shop management—call it works organization—call it production engineering—it is the applied science of so directing, so stimulating, and so rewarding the human intelligence which oversees the power-driven machine that the maximum of output shall be secured for every unit of input.

The idea underlying these methods is closely akin to that which was perhaps more concretely expressed in the epoch-making inventions. It is that the prosperity—the progress—indeed the very preservation—of society demands constant increase not only in the total production of wealth, but in the productive efficiency of each individual, and this is to be gained by continually freeing him from labor of a lower order so that he may concentrate upon work of a higher order. Every minute and every movement are to be devoted to the most profitable work of which the man and the machine he guides are capable. The quantity of the product, the quality of the workmanship, and the skill of the workman are constantly rising, because useless movements are avoided, and functions lower than those of which the agent is capable are constantly discarded and referred to the following grade in ascending evolution. It is "labor-saving," so-called, in the truest sense—which is only that all labour is saved for and devoted to profitable and wealth-creating ends, to its own vast advantage in the first and most direct share in the new profit and wealth. In the light of all history, labor-saving machinery and methods (far better call them "effort-saving")—result never in diminishing the opportunities for employment except very locally and transiently; the further result is a rise in the status of, and an incalculable increase in the demand for, labor.

* * *

It is only in the long and the broad view that the facts and their influences are seen in their true bearings, and length and breadth of view are too often lacking, in workmen—and, alas, in employers. They are too often impatient of any studies or any representations that go beyond the homely elements which they can see, and in which they are accustomed to think—a day's time, a day's pay, the cost of materials, the current wage, the present market, details of mechanical equipment, technical questions of engineering. And yet the most important matter of all is the cultivation of the highest efficienoy in the human forces by which the whole machinery of production is operated. "Labor-saving machinery" has made society vitally dependent upon labor as it never was

before; the science of labor management lies closer to the attainment of high economy in manufacture than does the science of thermodynamics; and the study of labor management takes us into the discussion of influences which are at the very foundation of the social order and the human experience. It is this conviction which inspires and more than justifies the attention THE ENGINEERING MAGAZINE has given in recent years to the underlying principles and problems of industrial economy and to their discussion by experts. Their solution is fundamental to the maintenance of the industrial *personnel* of the future, and far-seeing engineers and managers are becoming more and more generally recognizant of the fact.

* * *

THIS is the keynote of the age, and the key to the policy and purpose of THE ENGINEERING MAGAZINE. The province of the Magazine is the field of mechanical production and power applications—its inspiration the cheapening of production by the extension of labor-saving machinery and methods. Its course lies parallel with the foremost advance of the engineering industries. And, an essential to that advance being a firm grasp of the great facts of actual progress in labor-saving invention, the year just beginning will be marked by three special numbers, devoted comprehensively to three great phases of the subject—labor-saving through power applications, through works management, and through mechanical transport. Each will be a complete illustrated review of the latest and best practice—a symposium of the best authorities and a survey of the most widely known and successful shops. They will, in brief, show what is being done and how to do it. And they will serve to keep the Magazine, in its every issue, closer than ever to the best practice in what has been aptly called "Production Engineering."

THERE is in President Roosevelt's message an expression of the meaning and the relations of the Isthmian Canal which is so strong, so clear, and so adequate, that we are eager to quote it and anxious to impress it broadly and deeply upon the convictions of everyone who is or who may be concerned in the completion of the great waterway. It is a keynote—a watchword—for all, not least for the President himself, in all the steps which must hereafter be taken for the building of the canal. The principles which appear in our own course and our own methods must be no lower than those which (very rightly) we have prescribed for Colombia and Panama. The President says:

> "For 400 years, ever since shortly after the discovery of this hemisphere, the canal across the Isthmus has been planned. For two-score years it has been worked at. When made it is to last for the ages. It is to alter the geography of a continent and the trade routes of the world. * * *
>
> "This great enterprise of building the canal can not be held up to gratify the whims, or out of respect to the governmental impotence, or to the even more sinister and evil political peculiarities, of people who * * * dwell afar off. * *
>
> "The possession of a territory fraught with such peculiar capacities as the Isthmus in question carries with it obligations to mankind."

It is vastly reassuring to know that the President himself has set this measure upon the entire enterprise, for no lower ideals, of course, can then control the organization and administration of the work of building the canal. The next and immediate step—the appointment of the permanent commission—is no doubt the most momentous of all. The men selected for those posts will make or mar the success and glory of the undertaking. And it will no doubt need all Mr. Roosevelt's strength and steadfastness of purpose to see that nothing but pre-

eminent fitness is allowed to be the deciding consideration in selecting the members of the commission.

There will be tremendous pressure from many quarters to secure place for men whose fitness is far from pre-eminent; the President will be importuned to "gratify the whims of," or to yield respect to, political influence exerted in favor of professional impotence; he may even be threatened by yet "more sinister and evil political peculiarities of people who dwell afar off" from the Isthmus, but very near to the doors of the White House.

May he stand strong and inflexible in the actuating conviction that the "great enterprise of building the canal *can not be held up*" by any of these—that the sacred duty to appoint only men of absolute integrity, high executive capacity, and commanding professional standing and ability, is imposed, as he has so well put it, by "obligations to all mankind!"

* * *

THE relation of civilian to military engineering has always been fairly well defined, but in the United States there has existed a certain overlapping not found in other countries. Thus, both civil and mechanical engineers have been regularly employed by the Government in connection with the work of the army, and some of the most successful details of military work have been due to the labor of these men. Now all this is to be changed; the civilians are to go, and the soldiers are to do it all. This is as it should be, always providing that the soldiers are equal to the emergency.

In principle and in theory this position is undoubtedly correct. The Government maintains an extensive military academy, in which young men are taught at the public expense the art of war, including military engineering, and the fact that it has been found necessary to employ civilians to supplement and aid these men in their work certainly seems to reflect upon their capacity. Nevertheless it has been found necessary to employ outside help, and some of the ablest and most highly esteemed members of the profession have been engaged by the Government upon such work as gun construction, gun carriages, machine design, shop equipment, testing, and similar important matters.

It may well be doubted that men who have had no experience in such work can step in at a moment's notice and take charge of such work as a noted civilian engineer has been doing at Watertown, for instance, and it would seem the part of wisdom to permit the men who are experienced in such difficult and important work to transfer it gradually to those by whom it is to be conducted in the future. It may be the best way to teach a boy to swim by throwing him into the river, but in such a case there is nobody but the boy himself concerned; while in the important work hitherto intrusted to civilian engineers the whole nation is interested, and it seems like a rather costly and even risky experiment to proceed so hastily in the matter as present conditions indicate.

We are wholly in agreement with the principle that all engineering in the army and in the navy should be done by the men who have been trained at the public expense to do just such work, and there is no room for doubt that this should always have been the practice; but suddenly to amputate a most important branch of the service in order to put this theory into complete practice seems hardly the part of wisdom, or even of ordinary prudence. We shall watch the manner in which the soldiers proceed in this emergency, wishing them success with an interested anxiety.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE DETERMINATION OF WAGES.

PIECE WORK, PREMIUM PLANS, BONUS SYSTEMS, AND DAY RATES DISCUSSED, COMPARED, AND CRITICISED.

American Society of Mechanical Engineers.

AT the recent convention of the American Society of Mechanical Engineers a most active and interesting discussion was evoked by the presentation of several papers bearing upon the question of the determination of wages, and the importance of the subject is such that it demands extended review. The papers which drew especial attention were those by Mr. Richards, upon piece work, by Mr. Barth upon special slide rules for the ready performance of the computations involved with the use of the Taylor differential piece system, and by Mr. Gantt upon the general question of modifying systems of shop management.

Mr. Richards asked in his paper the question: "Is anything the matter with piece work?" and was most outspoken in his condemnation of wage systems which provided for any division of gain between the workman and the employer. Starting with the assumption of the establishment of a unit which is "the amount or quantity of work which the man should ordinarily be expected to do in a day for the ordinary day's wage," Mr. Richards proceeded to deduce the conclusion that the workman is entitled to a continuance of this full rate for all that he produces over and above the ordinary day's work. In other words, straight piece work follows as a logical conclusion from the assumed premises.

It is not difficult to put an outright fallacy into logical form, and this is what Mr. Richards appears to have done. In his case the fallacy lies in the assumption of the very thing which he sets out to prove, namely, that the proper wage for a workman for performing a known quantity of work, is already determined or determinable. In ordinary parlance this is what is called "begging the question." If Mr. Richards's premises are granted his conclusions certainly follow, but since his premises are really what he sets out to prove, he is simply traveling in a circle which lands him nowhere. So far as his paper is concerned, therefore, there is no need for considering it further. We know that there is no definite day's work and no determinate day's wage; these are the very things which some of the most earnest practical investigators have been trying to find out. They have learned that each man has a productive capacity of his own, that no two men are worth the same wage or are capable of doing the same work, and they have devised methods which to a greater or less complete extent act to discover just what each man can do and just how much wages he is entitled to receive. Fortunately there were at the meeting some of the most active and devoted men in the society in this department of work, and the discussions of Mr. Richards's paper by Mr. Taylor, Mr. Gantt, Mr. Emerson, and others, gave it a value and importance which would otherwise have been entirely lacking. It was a noteworthy example of the fact that the real value of a paper may often be found in the discussion which it evokes rather than for anything which it really contains.

In discussing the paper, Mr. Emerson

maintained that piece work is wholly wrong, that everything is the matter with it, and that it is a lazy, haphazard method of shifting responsibility and direction from employer to employee.

Says he:

"The fundamental trouble with piece work, in addition to its lack of justice, is that it makes the workman sell what is not his to sell, namely, output. When Mr. J. J. Hill formulated his famous principle that railroad expenses were by the train mile and receipts by the ton mile, neither his train crews nor himself ever dreamed of putting the pay of the men on a tonnage basis. The engineer who hauls sixty 80,000 lb. cars with a hundred ton engine gets no more than the engineer who obeys orders, standing for hours on a side track. The engineer sells his time, his skill, his intelligence, his obedience, but never output, because that depends on conditions over which he has no control; and it has always been a wonder to me that railroads which manage their train problems should be so backward in their machine shop practices and methods.

"What the employe sells, whether in office or shop, is not his 'output,' but primarily his time and his skill, incidentally his intelligence and his obedience."

After reducing the methods of day work, piece work, premium system, Gantt bonus system, Taylor differential system and some modifications to diagrams, and comparing them, Mr. Emerson proceeded:

"When all conditions are properly under control, I much prefer the Taylor diagram based on time. There is something inspiriting in working out a minimum time, in knowing that it can be made with the regularity that a train makes its fast schedule, in proving it, in stimulating the workman to it; but it is equally discouraging to workman, to expert and to employer to be wrecked in full flight by hard iron from the foundry, by variable speed in the engine, by broken belt on main shaft, by any unforeseen and unforeseeable delay, and in such cases the curve back to day rate prevents much trouble.

"Where, in all these lines and curves, when based on time, is there any support for Mr. Richards's contention that they cannot be effective because, as he claims, they offer a reduced incentive at the precise time when the need of incentive is most urgent? Exactly the contrary is true. They all of them offer, just as piece work does, ever increasing pay, which, if pushed to the theoretical limit, would reduce costs to almost nothing, and give the employe an infinitely large sum per day."

Mr. Gantt, in his paper examined the manner in which the Taylor system and his own daily balance method were viewed by practical men, and showed that but few people have grasped the proposed system as a whole, considering it rather as a series of isolated propositions which will do as well if not better when separated than when taken together as a whole. As a matter of fact, the method of Mr. Taylor, in reducing all work to unit times for elementary operations is an essential for accuracy in fixing piece-times for any pieces. When to this is added functional foremanship, with a daily balance, showing that the allotted portion of a job has been done each day, the subject is removed from the realm of empiricism and guess work and brought into the field of rational study and conduct. Each man can then be rewarded according to his value, and every man is provided with the means of making himself as valuable as his faculties will permit.

Some features of the discussion brought out the difficulty which men otherwise most intelligent, have in grasping the fundamental principle which Mr. Taylor has done so much to apply and expound. The ingenious features of the differential-piece-rate system have, in many cases, caused men to overlook what Mr. Taylor calls accurate scientific time study. Instead of attempting to fix a time for a new job by comparing former records and using these in connection with the foreman's judgment, Mr. Taylor established the method of timing the various elements, such as turning, planing, shaping, milling, etc, so that, with the available appliances the time required for a unit amount of any one of these elementary operations was accurately determined. Any new job could then be examined and the required amount of each of these operations taken and multiplied by its unit time, the result giving the proper time to be fixed for the completion of this new job. Under this system there is no difficulty in fixing accu-

rately the time required for any sort of a job, new or old, and in practice the system has been found to work perfectly well. Mr. Barth has carried this study of unit times still further, and has produced curves which show just what the interrelation of certain of the times may be, so that the speed required to remove a given quantity of metal in a given time may not only be determined, but the result for any other speed or time be computed. In like manner the relation of the life of a tool to its output, or the extent to which it can be pushed and yet hold out until the cut is finished; these, and similar shop problems have all been made the subject of study and scientific determination. In the light of such earnest scientific treatment of labor and its products, Mr. Richards's elementary paper sinks into insignificance, but it can at least be commended in that it brought out such a discussion from such men.

THE DEVELOPMENT OF SHIPBUILDING IN GREAT BRITAIN.

ABSTRACT OF THE PRESIDENTIAL ADDRESS OF SIR WILLIAM HENRY WHITE.

Institution of Civil Engineers.

IT is a growing practice for the presidential addresses before professional societies to embody a review of the especial branch of work to which the speaker has devoted his energies and in which he has attained eminence, and the custom is greatly to be commended. Instead of dreary platitudes, or vague generalties, we are receiving what are practically special monographs from eminent experts and the results form most worthy contributions to technical literature.

In the recent presidential address of Sir W. H. White, before the Institution of Civil Engineers, this idea is admirably carried out, so that we have, in the words of one of the foremost specialists in naval architecture, a resumé of the work to which his professional life has been devoted. The length of the address, and the limitations of space prevent more than a reference to the salient points, but the entire paper forms a most notable contribution to the *Proceedings* of the Institution.

Sir W. H. White's connection with shipbuilding began in 1859, when the highest achievements of the naval architect and the marine engineer were wooden three-deckers with screw propulsion. The Victoria, cited as a leading example of this class, was of 7,000 tons displacement, with but 4,200 horse power, making a speed of about 12½ knots. With this she had a full sailing equipment, while her armament consisted of smooth bore guns on wooden carriages, the heaviest being an eight-inch 68-pounder, firing spherical cast-iron projectiles.

Since 1859 nearly all the changes which have made modern marine engineering and construction what it is have taken place, and these changes Sir W. H. White has summed up as follows:

"In 1859 the highest steam pressures used in marine boilers were from 20 lbs. to 25 lbs. per sq. in.; twenty years later 90 lbs. to 100 lbs. had been reached, and the 'compound'—double-expansion—type of engine was in general use. Now in the mercantile marine, with the ordinary—water-tank cylindrical—boilers, pressures of 210 lbs. to 220 lbs. are common, and a little less than 270 lbs. has been reached in a few cases. For warships, with water-tube boilers, pressures of 250 lbs. to 300 lbs. have been used for nine years; but in the most recent vessels, in which 20 per cent. of the total power is in cylindrical boilers, with the balance in water-tube boilers, the pressure adopted is only 210 lbs. With these high pressures triple or quadruple-expansion engines are associated.

"There is a widespread feeling amongst marine engineers that, with cylindrical, or 'tank' boilers, it is not desirable to exceed 220 lbs. per sq. in. as the steam pressure; and, although quadruple-expansion engines are favored for the highest pressures used in the mercantile marine, triple-expansion engines are made in much larger numbers. For ships of the Royal Navy triple-expansion engines of the four-cylinder type are used, with two low-pressure cylinders and four cranks; and this is the arrangement adopted in many large-powered merchant

steamships. With higher steam pressures than 220 lbs., certain difficulties occur in the pipe joints and other parts liable to leakage of steam.

"This rise in pressure and greater expansion have been accomplished by an increased rate of revolution and piston speed. In 1859 for the best types of engines in screw steamers the revolutions did not exceed 50, and the maximum piston speeds were about 400 ft. per minute. In 1881 the averages for merchant steamers were about 60 revolutions, with 470 ft. per minute piston speed; now the corresponding averages are nearly 90 revolutions, and over 650 ft., while many steamers of high speed attain piston speeds of 900 ft. to 1,000 ft. The "Deutschland," at first, is reported to have worked at about 75 revolutions with over 900 ft. piston speed; on her later service the revolutions have risen to over 80 per minute with 1,000 ft. piston speed when developing about 36,000 H. P. with twin-screw engines. In warships the rates of revolution are higher and strokes shorter than in merchant ships. In 1881 the revolutions for battleships were about 80, and the piston speeds about 650 ft. to 700 ft. per minute. Now they have been increased to 100 or 110 revolutions, with 850 ft. to 900 ft. piston speed. For swift cruisers of large power, 120 to 140 revolutions and 1,000 ft. of piston speed are now common; smaller cruisers have about 220 revolutions with equal piston speed; destroyers have 350 to 400 revolutions and 1,100 ft. to 1,200 ft. piston speeds."

In connection with the modifications enumerated may be mentioned the change from horizontal to vertical engines, the introduction of water-tube boilers for cylindrical boilers, as these latter themselves had superseded the box flue boilers of earlier dates and lower pressures.

"Remarkable economies of weight in proportion to power developed have accompanied these changes. Taking the contractors' trials for the specified maximum power, it is found that each ton weight of propelling apparatus, in full working order, gave about 6 I. H. P. in 1859; whereas in present practice about 9 I. H. P. is obtained in battleships with cylindrical boilers, and about 10.5 I. H. P. with water-tube boilers. In large cruisers with water-tube boilers, such as the "Drake" class, about 12 H. P. per ton is obtained; in third-class cruisers with water-tube boilers, having thinner and smaller tubes, about 20 H. P.; and in destroyers from 40 H. P. to 50 H. P. The large cruisers have proved themselves capable of developing about 75 per cent. of their maximum power for continuous steaming at sea, which corresponds to 9 H. P. per ton; for the small cruisers and destroyers 50 per cent. to 60 per cent. of the maximum power can be maintained as long as the coal lasts; taking 50 per cent., this gives 10 H. P. per ton weight for the cruisers, and over 20 H. P. per ton for the destroyers."

In regard to the question of submarine boats, Sir William White has but little information to make public, although he admits that the Admiralty is giving the subject serious consideration. While maintaining that the problems concerning this class of vessels have been long studied and well understood, he admits that others have obtained the greatest practical experience in this work. Such work as the Admiralty has undertaken has been placed in the hands of the firm which has acquired the rights of Mr. John P. Holland, and Sir W. H. White says: "In the development of details, upon which success largely depends, experience is of the highest importance. Mr. Holland has unrivalled personal experience and great mechanical skill. Consequently, my advice to the Admiralty was to avail ourselves of the opportunity to secure that experience, and by concentrating orders in the hands of an eminent firm many advantages are gained, while secrecy is maintained."

The advantages obtained by use of the experience of Mr. Holland will be admitted, but the ability to maintain secrecy while similar boats are being built elsewhere remains to be seen. In any case there is every reason to believe that it is upon superiority in just such craft that coast defense in the near future will depend, while possibly the whole system of naval attack and defense will be revolutionized.

That sea power is most essential to all nations which possess a coast line is now admitted, while for an island kingdom, necessarily drawing its food supplies from abroad, as is the case with Great Britain,

naval supremacy is necessary for its existence. "This is no new doctrine; it was well understood and acted upon centuries ago. At times it may have been obscured, or there may have been neglect of adequate measures to insure supremacy, and a careless confidence that we could live upon the reputation of the past. No such mood now possesses the nation. The events of the last fifteen years prove that, at all costs, there is a resolve to maintain our position as the greatest naval power. Not as a menace to other nations, but as a guarantee of peace on the high seas, the free flow of commerce throughout the world, and the uninterrupted communication between the widely-scattered parts of our great empire. The navy—meaning the mercantile as well as the war fleet—is the essential bond of union between the mother country, the colonies, and possessions beyond the seas—the common assent of all. No better routes than the ocean offers can be found for the peaceful intercourse between us and our brethren, which is the great object of our aspirations, and our established policy is to hold these ocean highways open to all nations, claiming no monopoly or exclusive rights. Our war-fleets are the guardians, our merchant ships the messengers of peace. As was well said by the three Admirals in 1888: 'No other nation has any such interest in the maintenance of an undoubted superiority at sea as has England, whose seaboard is her frontier. England ranks among the great powers of the world by virtue of the naval position she has acquired in the past, and which has never been seriously challenged since the close of the last great war. The defeat of her navy means to her the loss of India and her colonies, and of her place among the nations.' Such a disaster can never happen so long as our national spirit is maintained."

WORKSHOP ECONOMICS.

THE IMPORTANCE OF ACCURATE COST-KEEPING METHODS TO THE ENGINEER AND MANUFACTURER.

American Academy of Political and Social Science.

ALTHOUGH bookkeeping as an exact science has long since been one of the essentials to commercial affairs it is only within the past decade that it has been seriously considered at length in connection with manufacturing. Attempts at shop records and cost-keeping have been made, it is true, but they have been regarded askance as themselves costing more than the information which they yielded.

Of late, however, the introduction of cost-keeping systems has made rapid development, and there is no longer any question as to the value of such records and methods to the proprietors of manufacturing establishments. For this reason a paper by Mr. Conrad N. Lauer in a recent issue of the *Annals of the American Academy of Political and Social Science* upon the importance of cost-keeping to the manufacturer is of interest and value, especially in that it brings the broad principles of modern methods to the attention of the general and non-technical reader.

"In order that the manufacturer may secure maximum production at a minimum expense, it is absolutely essential for him to know what his product is costing him. Not only is it essential to know the gross *cost*, but he must also know the cost at each stage of production. The three important divisions of the cost of any manufactured article are: Labor, material and general expense. The simple record of time and wages, in the pay-roll book, might appear to be sufficient as far as labor is concerned. If the subject be carefully analyzed, however, two very important subdivisions of labor will be found, namely: productive and non-productive. Productive labor is the labor expended in actually producing something. Non-productive labor is the labor which is not directly chargeable to some specific factory or production order. Each of the above elements of labor can be analyzed into other elements of importance.

"To a person unfamiliar with the subject, a cost sheet might be looked upon as something valuable merely as a means of determining or fixing a selling price for a given product. While this is, of course,

one of its functions, the general information it places in the hands of the manager is of no less importance. In the analysis of time and wages the cost account should so record all the factory expenditures as to enable the manager to be always ready to place his finger upon any unusual, or seemingly exorbitant, item of cost or expense."

So far as selling price is concerned, this is rarely determined, except in a secondary degree, by the determination of manufacturing cost. Far more frequently the selling price must meet market conditions, being governed by questions of supply and demand, and by all the disturbing influences of competition. An accurate knowledge of manufacturing costs is here all the more important, since it permits the owner to know how low he may safely sell without incurring loss, while his less accurately informed competitor may underbid the market in ignorance of his mistake. Selling must always be considered as distinct from manufacturing, but the selling department of a business should know positively the limits within which prices may be made.

The details of cost-keeping, into which Mr. Lauer goes to some extent, cannot be discussed in the limited space here available, and many of the most efficient and widely-used methods have already been fully described in the pages of this Magazine. Card-index methods, continuous records of work in progress, daily assembling or records, and especially daily allotment of tasks, with comparison of the extent to which they have been fulfilled; these form the elements of any system, the application and combination of the elements necessarily varying according to the local circumstances and conditions.

Mr. Lauer examines the question of the distribution of general expense, and advocates the method dividing this so that each article manufactured shall bear its due proportion. The older system of making this proportion a percentage of the wage charge on the article is shown to be incorrect, and the combination of an hourly rate for each machine in the shop, plus a percentage to cover that expense which is not directly chargeable to the machines, is recommended.

"This has been called 'The age of intensified production,' and this is surely true, for, no matter where you go, you will find manufacturers making heroic efforts to keep up with the tremendous pace set by some more energetic and systematic competitor. This being true, it is evident that he must, of necessity, keep a very close track of all the small details of his business.

"A few years ago a machinist would be fined for wearing out a tool. To-day the wise manager pays the man a premium for wearing it out—with the proviso, of course, that he accomplishes the work that the tool is capable of performing. Take, for instance, a lot of small sprocket wheels which have to be drilled. By careful analysis it is found that it will pay to run drills so fast that each drill press will completely use up one drill in a day of nine hours, in spite of the fact that twice as many holes could have been drilled by each drill used at two-thirds this speed. This could not have been determined except by a correct system of cost accounting.

"A few years ago the machine-shop manager paid seven cents per pound for his tool steel, and nursed both machine and tool. To-day he pays seventy cents per pound for tool steel, and drives both to the limit of their endurance. It would not be possible to determine such a great problem of shop economics by any loose system of accounting. He must know exactly what all this extra expenditure of money and energy is bringing him in return, in order to ascertain whether he is being repaid for his trouble and expense."

The question of the management of men and the methods of payment naturally comes up for discussion, but this phase of the subject has already been reviewed at length elsewhere in this issue. The relation of this department to the cost-keeping, however, is a matter for especial consideration.

"In an establishment paying its employees by any of the various piece-work plans, it is to the cost department that the manager will turn for information upon which to base his rates. In many establishments operating under a piece-work system, the cost-keeper is the man who fixes the rates. In all well-regulated plants he is the person who records all such transactions with the men, and sees to it that the workman receives his pay when the contract is completed. He not only records piece-work

time and wages, but has direct supervision of all time-keeping and payment of wages.

"Mr. Frederic W. Taylor, the pioneer and foremost inventor of advanced systems of shop management, has, in his plan of functional foremanship, considered the cost-keeper of such importance that he has made him one of his functional foremen. He has given him direct charge of the men, and made them directly responsible for all matters pertaining to time and cost. This leads to another line of thought. If a manufacturer decides to install a system of cost and factory accounting, and places a man in charge of the same, the cost-keeper will proceed to collect data and information, but he will be unable to make this data of any real value unless he is given the proper amount of authority to apply the facts so ascertained. No one can ever accomplish any real good if he is compelled to apologize to some one, at every turn, for having exceeded his authority. He must, of course, have respect for vested authority wherever he finds it, but he must also have sufficient authority vested in him to enable him to accomplish the desired end. If this is not the case, he would be very much in the position of a jockey who might be placed astride of a race horse and told to win the race, but on no account to use whip or spur. His only means would be gentle persuasion, and when the pace became hot he would fall behind, finish in the rear, or, perhaps, be distanced altogether.

"To sum up all this, the cost-accounting department must record all information relative to time and material, so as to be a means toward the end of reducing costs and expenses, and then, after such records are made, to assist in their application toward that end."

THE EDISON STORAGE BATTERY.

A RECORD OF PRACTICAL EXPERIENCE WITH THE ALKALINE ACCUMULATOR IN ELECTRICALLY PROPELLED VEHICLES.

Institution of Electrical Engineers.

ALTHOUGH the storage battery has found numerous practical applications, both for equalising the load upon generating stations and for the supply of current for electric vehicles, it has numerous disadvantages, which engineers and electricians have long sought to remedy. One of the most promising improvements in this line of work is the alkaline battery, of which the type designed by Mr. Edison several years ago has attracted the most attention.

In a paper recently presented before the Institution of Electrical Engineers by Mr. W. Hibbert some interesting practical information is given concerning tests made with an automobile equipped with an Edison battery, and as this is the most complete account of the apparatus which has been made public since the original paper by Dr. Kennelly several years ago the matter demands attention and review.

The principal advantages claimed for the alkaline battery are lightness, strength, and durability. These features are secured by the use of plates of sheet steel, carrying pockets of active material, and an electrolyte which is not decomposed, permitting the use of a sealed cell. Mr. Edison's characteristic criticism of the lead storage battery: "The darned thing is wet!" also applies to his own battery, but at least he has dispensed with the acid, and has enabled the containing cell to be closed against spilling.

In the standard automobile cell of the Edison type, such as was tested by Mr. Hibbert, there are 14 positive and 14 negative plates, each plate being made of sheet steel, nickel plated, and punched with 24 rectangular holes. In these holes are placed perforated pockets containing the active material, this material being nickel peroxide for the positive plates and finely divided iron for the negative plates, the materials in each case being mixed with flake graphite.

The liquid is a 20 per cent. solution of potash, and the whole cell is sealed in a steel case, provided with a stopper opening for adding water, and a vent hole guarded by a gravity valve to permit the escape of the gas evolved during the charge. The outside dimensions of the cell are 13 inches high, by 5.1 by 3.5 inches base, the whole weighing 17.8 pounds.

The most important question about the battery is supposed to be its relative weight. Mr. Hibbert gives the output as 210 watt-hours, which for a weight of 17.8 pounds gives 11.8 watt-hours per pound of cell. While figures nearly as high as this have been obtained with other cells it has been done only with considerable risk, and in the Edison battery it is the normal proportion. The weight of lead cells can be reduced only by making the supports very thin, increasing the fragility and shortening the life.

The influence of temperature on output is an important feature with the lead cells, but such experiments as have been made tend to show that even a marked rise in temperature produces but a small effect with the alkaline accumulator, much less than is the case with lead batteries. In the latter case a rise in temperature causes an increase in the rate of diffusion of acid, and the more rapid circulation causes a corresponding increase in activity. With the alkaline cell there is no need for circulation or diffusion of the liquid, and the only effect of an increase in temperature is a reduction in the internal resistance of the cell.

Mr. Hibbert gives a number of curves showing the behaviour of the cell under different conditions of charge and discharge, and these show conclusively that it can maintain a high rate of discharge. In testing to ascertain the maximum charging rate a cell was carefully discharged at 30 amperes, down to 0.75 volt. It was then charged for one hour, 177 ampere-hours being put in. The current was not quite steady, varying from 180 to 176 amperes. The subsequent discharge showed that 124 ampere hours were delivered, or about 70 per cent. of the charge. Experiments with motor car work show that the cell can be charged at over 200 amperes, and the maximum rate does yet appear to have been reached. Experiments with discharges varying between 60 and 230 amperes give a very interesting pressure curve, showing that the cell behaves like an elastic structure, its pressure rising and falling with the varying demand, but responding at such a rapid rate that the lines of changing pressure appear vertical.

The most interesting portions of Mr. Hibbert's paper, however, are those relating to his practical experience with the Edison battery in operating an automobile. A Studebaker runabout was fitted with 38 Edison cells, the whole outfit, including two passengers having a weight of 1,950 pounds. 700 pounds of which were due to battery. Although the motor was a 40-volt, 24-ampere machine, the battery gave an average pressure of 48 volts, so that the conditions for successful working were not the most favorable. With this outfit a speed of 14 miles an hour on a level was obtained, the power being about 1,920 watts, corresponding to 2,200 watts per ton, and giving a tractive effort of 79 pounds per ton. Allowing 85 per cent. for motor efficiency the tractive effort is 67 pounds per ton.

The work appears to be about 135-watt-hours per ton-mile, a higher figure than has been obtained elsewhere, but not unexpected, considering the want of balance between the battery and the motor.

A diary of road and general service of this vehicle, in France and in England, shows an excellent record, runs of 30 to 40 miles on one charge being given, with much irregular service, there being a total of 508 miles, which, added to 400 miles run before Mr. Hiblert took control, gives 908 miles. Tests made in connection with these road trials practically confirmed the previous laboratory investigations. A 40-mile run in England, occupying 3½ hours, gave 150 ampere-hours, while the laboratory tests at the same rate showed 159 ampere-hours. Observations of varying rates of discharge showed that with 50 to 60 amperes on a level the rate rôse to 90 to 100 on slopes, and in one instance was over 150 amperes. Results of rapid charging are also interesting. In one instance, owing to local conditions it was necessary to charge rapidly, 150 ampere-hours being received in one hour, and in the subsequent run 107 ampere-hours were delivered, an efficiency of 71 per cent. Again, after having been allowed to stand discharged for ten days, the battery received 186 ampere-hours in one hour, and the subsequent discharge, during a 31 mile run about London yielded 134 ampere-hours, or 72 per cent. of the charge.

So far as the important question of durability and permanency is concerned, the experience seems hardly extended enough to enable full information to be secured, but the battery showed no appreciable deterio-

ration during the experience which Mr. Hibbert had with it, although the conditions were such as to give this feature a reasonable test. Mr. Hibbert says, concerning the connections: "My 500 miles on the road were sufficient to test them, and not one of them failed or became weak. Not one of the terminals had to be touched from the beginning to the end of the run. We had rough roads and rough weather, so that the motor was seriously overloaded, and the car was so strained that it had to go into serious repair as soon as our run was finished, but the battery and its terminals endured it all."

THE GENERATION OF SUPERHEATED STEAM.

DATA AND RESULTS OF EXPERIMENTAL INVESTIGATIONS OF PRACTICAL STEAM-SUPERHEATING APPLIANCES.

Dr. Otto Berner—Verein Deutscher Ingenieure.

FOR a long time the advantages of using superheated steam in engines have been understood and appreciated, and many years ago a variety of superheaters were designed and put in operation. In fact, the disastrous explosion which occurred on the steamship Great Eastern on her trial trip consisted in the bursting of a tube of the superheater which was fitted in the uptake, and was the cause of the death of several persons. The lapse of time which appears in the practical application of the well-known advantages of superheating may well be attributed to the constructive difficulties which have been encountered, both in the superheating apparatus and in the engines in which the high-temperature steam is to be used.

At the present time, however, the improvements in metallic packings and in lubrication, as well as the introduction of the steam turbine, have called attention once more to superheating, and it is realized that there is probably no more available direction for the improvement of the efficiency of steam motors than in the line of superheated steam.

Under these circumstances the paper of Dr. Otto Berner, published in recent issues of the *Zeitschrift des Vereines Deutscher Ingenieure*, discussing the present appliances for generating superheated steam, is especially worthy of attention.

After a brief examination of the thermodynamics of superheated steam, Dr. Berner proceeds to examine the materials of which the superheater may be constructed. The range of choice is not great, the materials available being either a cast metal, cast iron in practice, or wrought metal in the form of tubes of wrought iron or steel. Although cast iron was largely employed in the construction of the early superheaters there is present but one design in extensive operation in which this material is used, the well-known Schwörer superheater. Many installations of this apparatus have been made during the past ten years, and the durability and reliability of cast iron for the service has been fully established. Dr. Berner gives the records of a number of these superheaters, showing their performance to be excellent. In the great majority of designs, however, tubes of wrought iron or steel are employed, and the extent to which these materials meet the requirements is examined.

Apart from the actual resistance to the pressure of the steam, the principal property demanded of the material is durability. Superheaters are exposed to corrosive action from the steam within and from the furnace gases without.

The corrosion or pitting of the interior of superheaters has not been given especial study. It has been attributed to the action of free oxygen, liberated by the dissociation of the steam, and although the temperature of the separation of the oxygen and hydrogen is given as from 1,000 to 2,500 degrees centigrade, there is reason to believe that it commences at a much lower temperature, so that it is possible that oxidation may result from this cause. The limited observations which have thus far been made do not indicate any difference in the extent of this action upon cast or wrought iron. So far as external corrosion is concerned, the extent of the action appears to depend upon the temperature. For temperatures of 250 to 300 degrees centigrade no appreciable difference appears between cast and wrought

iron, and for higher temperatures data are lacking. The fact that cast-iron superheaters are made to such a limited extent practically dismisses them from extended consideration in the investigations upon which Dr. Berner makes his report, and leads us to consider the elements upon which the design of tubular superheaters depends.

The rate of transmission of heat to the steam is a question of importance, and this appears to depend to a material extent on the arrangement of the parts. Tests made with the flow of hot gases in the same direction as the flow of the steam in the tubes gave lower results than when the flow of gases took place in the opposite direction, the hottest gases meeting the hottest steam. By using the latter arrangement the efficiency is shown to be nearly 19 per cent higher than with the former, a result which is in agreement with the views of Rankine as regards the action of heat in steam boilers.

The performance of a superheater depends upon several elements, and the tabulated results of tests of various cases enable interesting conclusions to be drawn. The percentage of moisture in the steam delivered to the superheater affects its work very materially since a portion of the heat delivered to the superheater is expended in evaporating this moisture. The idea of using a superheater to enable a priming boiler to deliver dry steam is not to be commended, and it is desirable, if the best efficiency is to be secured, that the boiler be so designed as to deliver saturated, but not moist steam to the superheater. The rate of heat transmission to the superheater varied greatly with different kinds of boilers, this evidently being due to the rate of flow of the gases over the superheating surface. According to the experiments examined by Dr. Berner, the coefficient of heat transmission, that is, the number of heat units transmitted per square metre of superheater surface per hour, varies greatly for boilers of different kinds, owing to the differences in the velocity of the gases. The velocity of the steam must also be taken into account, and when the superheater tubes have a small area, giving to the steam a correspondingly high velocity, the value of the coefficient was found to be materially reduced. The actual results of the experiments of a local section of the Verein Deutscher Ingenieure are fully tabulated by Dr. Berner, and these show that before any extensive installation is to be made the value of the coefficient should be determined for the actual conditions under consideration.

In general conditions the highest results are obtained by using independently fired superheaters, and although these involve the combustion of additional fuel they may in many instances be found more economical in the long run. When the grate and heating surface of the boilers are properly proportioned to each other the temperature of the discharge gases should be too low to enable them to be employed to advantage in superheating the steam. The superheater should not be installed to make up for deficiencies in boiler design, but should stand on its own merits as a separate auxiliary apparatus.

Various devices have been made to effect a thorough transfer of the heat to the steam. In the Schwörer superheater, already referred to, the cast-iron tubular sections, of comparatively large size, about 7 inches inside diameter, are made with extended surface in the form of circumferential ribs or fins on the outside, and longitudinal ribs, somewhat like those of the Serve boiler tube, on the inside, this arrangement retarding the flow of gases and steam and affording increased heating surface. Another type of superheater is made with spiral partitions inside of the tubes, thus causing the stream of steam to rotate and come into contact with all parts of the heating surface. There is no doubt that such devices increase the coefficient of heat transfer, and thus enable a smaller superheater to be used than would otherwise be practicable.

While the experiments upon which Dr. Berner's paper is based cover but a period and practice the manner in which the data are tabulated render his paper a valuable one, especially in view of the lack of reliable information upon this important subject. Too often the discussions upon superheated steam deal entirely with the use of the steam after superheating has been accomplished, leaving out of consideration the important questions connected with the design of the apparatus necessary for its production.

THE MONEY VALUE OF TECHNICAL TRAINING.

A COMPARISON OF THE INDUSTRIAL EARNING CAPACITY OBTAINED FROM VARIOUS DEGREES OF SCIENTIFIC KNOWLEDGE.

American Society of Mechanical Engineers.

WHILE there many things of which the true value cannot be measured in money, yet the use of monetary terms often enables comparative statements of value to be made in a manner which appeals to the general reader in a very effective manner. Taking this basis for his argument, Mr. James M. Dodge, the retiring president of the American Society of Mechanical Engineers, took up in his presidential address the question of the money value of different degrees of technical training, plotting in a diagram the potential values of men in various lines according to the capital of which their respective earning powers are the interest. As to the correctness of the view which assumes that a man can be thus capitalized, there may be several opinions, and if this principle is no sounder for men than it has shown itself to be for certain industrial enterprises, there may be an element of uncertainty in the deductions, but as a comparative method it may be accepted, in lieu of any better basis.

Mr. Dodge divides his material into four groups; the first representing untrained labor, the second the shop-trained men, the third those who have had the advantages of trade-school instruction, and finally the graduates of the technical schools. The diagram shows at once that the force of any comparison depends upon the stage in the career of the man at which the comparison is made. The men having the lower degrees of school training begin to earn money sooner than those who invest that portion of their time in study, but as time goes on the inclinations of the curves change. Soon the line representing the unskilled labor assumes the horizontal position, and as the years go on it rises no higher, there being no basis for further development.

The trade-school man, on the contrary, starts up at a rapid pace, but he too begins to slacken off, and gradually approaches a uniform rate, although naturally much higher than that of the unskilled man, while the shop-trained group occupies a place about midway between the two. All these curves have the same general characteristics, being practically concave to the base at all times, and thus possessing a difference in degree only.

The curve representing the technical school group, on the contrary, is of a different kind, being convex to the base for nearly its entire length, the rate continually increasing until nearly the maximum is reached, when it too, like the others begins a reverse curvature, but not approaching nearly to a horizontal within the limits of the diagram, which extends to the age of 32 years, the average weekly income of the technically-trained man at that period being given as $43.

Although the number of examples from which these data are derived seems hardly large enough to permit any very sweeping generalizations to be made, there is little doubt that they indicate broadly the tendencies of the times.

The distribution of workers in the different grades of occupation naturally depends upon various conditions.

"It is quite obvious that all workers in the mechanic arts cannot be technical graduates. Some must, through natural limitations, or lack of opportunity, follow the apprentice line, and others the trade school. It is from graduates of the latter that leading shop men and foremen are largely selected. These two classes, supplemented by the technical graduate, constitute the vast army of workers in the mechanic arts.

"Thus we see clearly that preparation pays, and that it pays in dollars and cents, and that even a long term of years spent in proper study and technical training is a good investment from every point of view.

"Of course, apprentices have made and will make, in rare instances, a better showing than the average technical man of the chart, and many of our greatest men have, by sheer force of character, excellence of brain fibre, persistence and self-education, risen to preëminent positions, independent of all regular systems. To the end of time great examples of this kind will be found.

Among those whose names readily come to mind are the elder Krupp, Joseph Whitworth, George M. Pullman, Andrew Carnegie, John Fritz, Prof. John E. Sweet, Edwin Reynolds, George H. Babcock and Coleman Sellers.

"The same is true of the trades school graduate, but as said before, we are dealing with the average of each class, taken from actual statistics, with an earnest desire to ascertain the facts, and without any preconceived notion of the outcome."

An important feature in connection with the value of labor is brought out by Mr. Dodge, when he states that it is a truism that every man pays for the amount of bossing he requires, and that every man's wages increase in proportion to his ability to act as a boss or foreman of himself or others. One of the great advantages to the employer of high-value labor is the fact that the cost of superintendence is greatly diminished, while the ability of a man to manage himself is the greatest of all capacities, reached to the highest degree only in those eminent instances of the heads of successful enterprises.

"The highest wages are paid to the man through whose ability the largest number of other men may be most profitably employed. He does his work with his brain. Thus, on the one hand, we see manual labor receiving no wages, and on the other mental labor reaping the highest reward. Between these two extremes is found every condition of human life.

"A practical man performs his work within the radius of his arm, a technical man within the radius of his brain. This fact is, even to-day, realized by the few, but it is gratifying to know that the number is increasing.

"The technical training of an individual makes him valuable just in proportion as his ability is manifested by good judgment and perception. Trained common sense receives the highest compensation and reaps the greatest reward.

"Mental ability to receive ideas and impart them properly and wisely, rearranged and grouped, is typical of the most brilliant mentality; a dull intellect may be compared to blotting paper, fit only to absorb and inter a heterogeneous mass of impressions."

THE DEFORMATION OF MATERIALS.

A STUDY OF THE MANNER IN WHICH EXTERNAL STRESSES ACT TO PRODUCE INTERNAL STRAINS IN METALS.

H. Bouasse—Société d'Encouragement pour l'Industrie Nationale.

AMONG the advances which have been made in the applied science of engineering one of the most interesting is the progress which appears in the treatment of the strength of the materials of construction. Formerly it was considered sufficient if a few experiments were made to ascertain the load which a given material would bear before rupture took place, and the engineer was held to have done his duty if he proportioned his structure so that the load never exceeded a certain fraction of this breaking load, this fraction bearing the imposing name of "factor of safety." Some engineers held that a factor of safety of 10 was necessary, others, less conservative, were satisfied with lower proportions, but the whole consideration of the matter was empirical and arbitrary, and had no basis in any real knowledge of the true behaviour of the material under stress.

With a more scientific study of the manner in which various material resisted the action of stresses a more rational view of the subject began to obtain, and at the present time the whole tendency of the ablest engineers is to get entirely away from empirical formulas and methods and to consider each material by itself according to the actual conditions of use. This point of view has brought into prominence the fact that long before the breaking load is reached a material suffers molecular changes which render it unfit for further loading to any extent.

The improvements in testing machines and in the apparatus for recording the relation of load to deformation have taught us much concerning the true behaviour of materials under stress, and in an article upon the deformations of materials, by M. H. Bouasse, in a recent issue of the *Bulletin*

de la Société d'Encouragement pour l'Industrie Nationale, this side of the subject is discussed in a very interesting manner.

M. Bouasse emphasises the necessity of differentiating the work of the engineer in the study of materials from that of the physicist. The latter, in his laboratory may undertake investigations of a high degree of precision, and the results, wholly accurate and interesting may yet be of comparatively small value for the purpose of forming the broad generalizations necessary for the framing of laws and formulas for the working engineer.

Taking up the much-discussed question of the limit of elasticity, M. Bouasse examines the case of a wire subjected to a load increasing in proportion to the time, and gives the diagram corresponding to the conditions of stress and strain. He emphasises the fact that there is no abrupt or sudden change in the curve indicating a precise point at which the extensions cease to be directly proportional to the loads, the rate of stretch increasing gradually, forming a rounded corner in the diagram. In other words, a pronounced region of inflexion is found on the curve, but not an abrupt angle. At the same time he admits that an approximation to the true limit of elasticity may be deduced from such a record, and considers that such an approximation may safely be used in the practice of machine design. M. Bouasse puts himself on record as affirming that the ultimate breaking load is of no scientific value whatever, so far as the researches of the physicist are concerned, although it is possible that it may be of some service to the engineer.

The law of Tresca is cited as of especial value to the engineer, this principle being that, with repeated removals and re-applications of the load in the testing machine, the curves drawn will practically coincide so long as the stress is within the elastic limit; practically such curves are straight lines of very slight inclination.

M. Bouasse examines in detail the complex phenomena which accompany the production of deformations in materials, and considers the influence of various methods of producing deformations upon the results. Thus it is quite possible to apply loads in such a manner as to permit altogether erroneous conclusions to be drawn, and unintentional or premeditated deceptions may be produced. A series of tests, alike in all respects with the exception of the speed of application of the load revealed the influence of the time element, a heavier load being required to produce the same extension in a short time than is necessary when the force is applied more slowly.

When it is understood that a difference of 10 per cent. or more in the apparent strength of the material may appear from this source alone, the importance of considering the time element is evident. This difference is that due alone to the behaviour of the material under rapid test, and is in addition to the error which may be caused by the inertia of the operative parts of the testing machine itself.

The influence of local hardening of the material under test is examined at length by M. Bouasse, and he shows very clearly that any assumptions based on a supposed uniformity of conditions throughout the whole test piece may lead to very misleading results.

So far as actual testing is concerned, the investigations of a material may be made according to three different methods. In the first case the material may be examined in connection with the completed structure of which it forms a part, as, for example the metal of a tire, in place upon the wheel where it is to be used. In such cases, theoretical considerations are entirely out of place. The important matter is to reproduce, as nearly as possible, the actual conditions under which the object is to be used. The wheel may be broken under a hydraulic press, but the conditions imposed by the artillery tests are more practical, these consisting in placing the wheel upon a caisson or a gun carriage, and hauling it over several hundred kilometres of broken country.

The second kind of test includes the material before it has reached the final form and position of actual use. In such instances the final destination of the material may even yet be indeterminate. Here the only requirement should be the conformity of the piece under test to certain stated requirements of specifications, or its correspondence to a given standard of comparison. Even here a theory of deformations is inapplicable, and while the results may be

of the utmost importance and value in construction, they are altogether unsuitable to be used as the basis of a scientific theory. In the third kind of tests the whole aim should be the procuring of data from which to deduce the theory and the actual laws of deformation. Such testing is the proper work of the physicist, to be performed in the laboratory, entirely apart from the practical considerations which must control actual working tests of the two previous classes. Only by the comparison of a vast number of laboratory tests can the true scientific laws of the deformation of materials be determined, but when thus determined, they will be rational and not empirical laws, capable of practical applications of the highest value.

ELECTRICITY IN MANUFACTURING PLANTS.

THE RELATIVE ADVANTAGES OF GROUP AND INDIVIDUAL DRIVING OF MACHINERY IN SHIPBUILDING AND MACHINE WORKS.

Society of Naval Architects and Marine Engineers.

SEVERAL years ago the question of equipping some government shipyards was under consideration, and there was some uncertainty as to the practicability of introducing electric transmission instead of shafting, belting and steam piping. To-day the only question in such a connection is as to the choice of electrical methods of transmitting and driving, all other methods being out of consideration. With this as his text, Mr. Walter M. McFarland presented a very interesting paper upon the use of electricity in manufacturing plants, before the recent meeting of the Society of Naval Architects and Marine Engineers, and his experience, both in naval affairs and in applied electricity, renders his opinions of especial interest.

A few years ago the steam engine was the only prime mover considered at all, either in shipyards or any other manufacturing works. The transmission was a combination of line shafting, countershafts and belting, and the greater part of the whole transmission system had to be driven whether one or all the machines were to be operated. The difficulties of such a centralized power system, with its attendant distribution problems, has led to the use, in shipyards and in widely extended manufacturing establishments, of a number of separate boiler houses, supplying steam to small engines placed near the machines to be driven. This method involved the use of small, wasteful engines, in the place of larger and more efficient ones, together with all the losses and inconveniences of steam pipe-lines, but the advantages of sub-division often overbalanced these objections. Pneumatic transmission has been introduced for the special tools for which it is so well adapted, and hydraulic power is employed for large riveters and flanging machines, but these have formed minor portions of any large plant.

"The disadvantage of long lines of shafting was thoroughly realized before electricity offered such a simple solution of the difficulty. Unless the greatest care was used in keeping the shafting in alignment and the journals well oiled, the power wasted in the friction of bearings and belts was a very large percentage of the total power of the engine. The results of numerous experiments to determine these losses have been published repeatedly, and show that they have varied from 8 or 9 to 80 per cent. of the power of the engine. That there should have been even the minimum loss when all the tools were in operation was bad enough, but unfortunately, from the nature of things, this loss was going on all the time, even when only a few tools were in operation, as it was practically constant and independent of the load. A preliminary solution of this difficulty was to divide the shafting into short lengths, driving groups of tools and operating each group by a small steam engine, but this introduced the lower efficiency of small engines and the complication of long lines of steam piping with the inevitable losses due to condensation. There was also involved additional supervision, as each engine would generally require a considerable part of the time of a man to look after it. With the case of a very large establishment with numerous power plants scattered over its area, the conditions were still worse for

economy, as it was practically impossible to have the best skill at each one of these little plants, and, as a rule, they themselves were not economical.

"When we compare the conditions obtaining with electric transmission, the contrast is very great. Instead of the long lines of steam piping with their attendant condensation and heating of the spaces through which they pass, we have the small flexible wires conveying current, which can go anywhere and as a rule are located in spaces not useful for other purposes. Both generators and motors have a high efficiency and, speaking generally, the part of the apparatus requiring skilled attention is almost entirely concentrated in the power plant. There are no losses from condensation, and the analogous loss, that due to the heating of the wires consequent upon transmitting the current, is, for the distances common in industrial establishments, so small as to be a matter of little moment. The electric motors lend themselves readily to small subdivisions of power, the efficiency of small motors being only a little less than that of large ones as contrasted with the enormous reduction in economy of small steam engines. In consequence it is practicable to use the motors either for individual tools or for groups of tools. In either case, there is no loss comparable to that of driving the long lines of shafting and belting to operate a few tools, and power is only supplied in proportion to the actual call for it, for even in the case of group driving the groups would be relatively small and of such a nature that it would rarely be the case that a whole group would have to be driven to give power to a single tool."

The introduction of electricity in manufacturing plants has been gradual, beginning with electric lighting, followed by the employment of the current for operating machines for which the ordinary methods were difficult of use, such as travelling cranes and similar machines. The great convenience of these applications, and the existence of a supply of current in the shop led to its continual extension whenever small amounts of power were wanted at points not already conveniently supplied, a single motor at first being used to drive a countershaft for several tools, the so-called "group" system, followed by the still more highly differentiated method of providing an individual motor for every machine.

"Considered alone and for the individual tool, the individual drive is ideal. It enables the power to be applied just when wanted and only when wanted, and further enables each tool to be used under conditions of maximum efficiency. The objection will occur at once, however, to any practical man, that the enormous multiplication of small motors means increased complication and greatly increased cost. For example, the cost of a ten horse-power motor is very far from being ten times the cost of a one horse-power, and although, as stated above, the efficiency of small motors does not fall below that of large ones to any such extent as the difference between small and large steam engines, nevertheless there is a material difference. Some engineers go so far as to say that they would have a motor for each tool, even if it involved going to sizes as small as one-quarter horse-power, but the writer is inclined to believe that the judgment of more conservative engineers is favorable to individual driving where the power required will be, say, from five to ten horse-power and upwards, and for group driving where the individual tools would require less than those amounts. In any large plant there are numerous small tools, such as drill presses, screw-cutting machines, light lathes, etc., which are in any case located together, and where it is perfectly easy to drive them as a group. The average power required for such a group will be quite uniform, and when they are group driven a moderate sized motor, with its relatively high efficiency, can be used with a fairly steady load, thus contributing to the efficiency of the general system, as well as of the particular group, and reducing the first cost of the installation."

Mr. McFarland examines at length the relative adaptability of the continuous-current motor and the induction motor for machine driving. This is undoubtedly a matter of controversy at the present time, and there are valuable features in both systems. The direct-current motor has the advantage of variable speed, and having been the first in the field it has had the advantage of familiarity and experience. The induction motor is by far the simpler machine,

and possesses a high efficiency, but, unless specially arranged it is a constant-speed machine, and requires the intervention of cone pulleys and belting between it and the machine. This is not altogether an unmixed evil, since the arrangement is scarcely more complicated than the commutator construction of the direct-current machine, and further the advantage of the "low-gear" effect of the cone pulleys on slow work is often desirable, slow speeds usually being accompanied with heavy demands for power.

The various systems of multiple wiring and multi-voltage are examined by Mr. McFarland, and the future possibilities of these methods are indicated.

"A feature of great interest in connection with the use of electricity is its cost as compared with that of older methods. Before giving some figures of a careful test which was made of the two systems, it may be remarked that in a thoroughly efficient plant it is probable that the cost of power rarely exceeds from 5 per cent. to 10 per cent. of the total cost of the product, so that it is obvious that even a very large percentage of saving in the cost of power will not reduce the total cost of the product very materially. Nevertheless, in a very large plant the saving would be quite respectable. The truth is that while the electrical system of transmission does secure a material reduction in the cost of power, this, after all, is not its greatest recommendation. The greatest benefit comes from the elasticity of the plant consequent upon its use. There is no longer any necessity for the rigidity of arrangement which obtains with shafting and belting, so that if it becomes necessary to rearrange the plant at any time the expense is reduced to a minimum. In the New York Shipbuilding Co.'s plant, for example, many of the tools being absolutely self-contained were not secured to foundations at all, and could be moved to any position desired, although these tools are not of the kind ordinarily considered as portable. The use of individual motors, and the consequent reduction in the amount of shafting and belting employed, makes the shops very much lighter, and gives overhead freedom for crane service with attendant increase in economy of production due to the greater efficency of the employees working in better light.

"To sum up, we may say that by the use of electricity for power transmission we secure an enormous increase in the flexibility of design of the plant, being able to locate the power plant itself and the various shops where the circumstances of the case require them for efficiency, the lines for transmission being so small as to make moderate variation of length unimportant. We also secure a marked economy in the cost of power, a greater efficiency in the machine tools themselves, and a greatly increased efficiency of the personnel, due to the increased habitability and cheerfulness of the shops."

GAS ENGINES FOR FURNACE GASES.

THE UTILIZATION OF LEAN FURNACE GASES FOR THE ECONOMICAL PRODUCTION OF MOTIVE POWER.

American Society of Mechanical Engineers.

AT the recent meeting of the American Society of Mechanical Engineers a paper was presented by Mr. Charles H. Morgan, describing a design of internal combustion motor especially designed for use with the lean gases discharged by blast furnaces, and the paper and the discussion which it elicited draws attention to this important source of motive power.

Mr. Morgan's design presents a number of valuable points, including the use of several cylinders, connected to rocking beams, enabling the mechanical efficiency of the machine to reach a maximum, while the valve gear is so arranged as to give a two-cycle effect in each cylinder, with a thorough scavenging of burnt gases each stroke, before the admission of the fresh charge.

Mr. Morgan referred to the statement of Mr. Campbell, that the gas engine was a "cannon with its projectile fastened to a crank shaft," but it is clear that this definition was an erroneous one, derived from the old Otto and Langen engine, in which the piston was a projectile, it is true, but not fastened to the crank shaft, since the up-

ward movement of the piston was free, and the effective stroke was the downward one, due to the suction following the explosion, there being only a ratchet and pawl connection of the rack piston rod to the pinion and shaft.

Mr. Morgan calls attention to the value of waste furnace gases as a source of motive power, and recognizes the difficulties which attend their successful use.

"Like the dependence of the steam engine upon its boiler for uniformity and quality of steam so is that of the gas engine upon the producer for suitable gas. Nor is such gas easily obtained. Blast furnace and producer-gas, especially the former, contain large amounts of dust which comes from the ores, limestone and ash, and which is driven out with the blast. This dust has been the *bete noir* of the gas engineer in attempted utilization of the gas. Clogging the checker work and flues when used for reheating, impeding combustion when burned under boilers, and cutting and grinding vital parts of the machine when used in gas engines. Various devices for 'washing' or eliminating the dust have been devised, when, in the year 1900, German engineers discovered the value of passing the gas through a simple centrifugal fan blower injected with a small spray of water. The result has been exceedingly promising and when perfected will doubtless solve the troublesome problem."

In discussing the paper, Mr. B. H. Thwaite, himself identified with the earliest efforts to utilize these sources of motive power in the wastes of blast furnaces, called attention to the fact that the lean gases, of low calorific power, such as are obtainable as a by product of the manufacture of iron, are the very ones which enable the highest thermal efficiency to be secured in internal-combustion motors. A rich gas enables a larger power to be secured from an engine of a given size, but the lean gas, containing only 100 to 120 thermal units per cubic foot, is far more efficient when used in properly designed engines. Such gases require a smaller proportion of air to form the combustible mixture, the correct proportion being about 1 to 1, the principal requisite being a sufficiently high degree of compression in the cylinder. It is well known that a high compression is conducive to a high efficiency, but with a rich gas such a compression is impracticable because a temperature of compression is soon reached at which the mixture will ignite. With the lean gas a higher compression may be employed without any such risk, and in general it may be stated that the degree of compression should be inversely as the calorific power of the gas employed.

The magnitude of the question of the utilization of furnace gases may be gathered from the investigations of Mr. Uehling, who stated that he had determined the available power to be about 840 horse power per hour per ton of pig iron produced by the blast furnace. This computation is based upon the total calorific power of the gases discharged from the furnace, taking the thermal efficiency of the engines at 25 per cent., a rate which is decidedly within the limits of ordinary practical operation.

An interesting suggestion which has been made in this connection is that of the combination of ordinary and electric smelting, the blast furnace to be used to smelt the pig iron from the ore, and the electric furnace to refine the crude material to the finest steel, the power for generating the electric current being derived from the otherwise waste gases from the furnace. In this way the chief difficulty of electric refining—the cost of the power—may be eliminated, the pig iron being caused to furnish the power with which it is to be refined.

The utilization of furnace gases is one of the most important power problems of the present time. Many criticisms have been made of the wastefulness which has attended the exploitation of natural gas, and no condemnation can be too strong of the manner in which those vast natural resources of power have been squandered. All the time, however, we have been burning coal for the purpose of smelting iron and allowing a most valuable portion of the combustion to go to waste. The employment of a small portion of the heat in the waste gases to heat the blast and to fire the boilers has been admired as a noteworthy economy, while all the while a far greater portion of the energy in the coal has been lost.

Doubtless a partial reason for this indifference has been due to a feeling of uncertainty as to the reliability of the large gas engine. As Mr. Morgan says: "The gas

engine has been looked upon askance. Its early life has been a synonym of unreliability. Echoes of its dying gasp as it came to a peaceful standstill, visions of workmen wrestling with the fly wheel to start it anew, are still fresh in the minds of users of power. Yet with all its faults it has gone on steadily from good to better things. The chance of cutting the best known steam engine economies a half or a third is a prize too tempting to ignore."

In this appreciation of the advantages of the gas engine for large powers, America has been far behind Continental Europe. Visitors to the Paris Exposition of 1900 will well remember the great 600 horse power Cockerill gas engine, and at that time its companion blowing engine of equal size was steadily operating at Seraing, day in and day out. In Luxembourg, in Belgium and in Germany, engines of equal size and larger have been built for several years as articles of general manufacture, and the names of Delamare-Debouteville, von Oechelhaeuser, and Koerting, are well known as builders of such machines. Mr. Morgan will have done well if he does nothing more than to arouse the iron masters and coke burners of the United States to the fact that they are throwing into the air thousands upon thousands of dollars which their competitors are gathering in and utilizing, and if his paper and the discussion which it elicited but brings a realization of this waste home to those in whose power its control is placed, he will have rendered a great service to the industries of America.

THE LOCALISATION OF ENGINEERING SOCIETIES.

ADVANTAGES OF THE FORMATION OF BRANCH SECTIONS FOR THE DEVELOPMENT OF LOCAL INTEREST AND SPECIAL WORK.

Robert Kaye Gray—Institution of Electrical Engineers.

IN the course of a paper on the homes of the great engineering societies, published elsewhere in this issue, mention is made of the extent to which the Society of German Engineers has extended its work by the formation of local branches in all parts of the empire, these holding their own meetings under the general supervision of the main body. In connection with the recent revision of the constitution of the American Society of Mechanical Engineers this matter was also considered, and provision was made looking to the formation of such local branches when occasion should offer. As a portion of his recent presidential address before the Institution of Electrical Engineers, Mr. Robert Kaye Gray touched upon this important question, and his remarks may well be considered by other organisations at this time. Mr. Gray said:

"For the future development of the usefulness of the Institution there appears to me to be one matter worthy of our utmost attention. The Institution membership extends all over England and the Colonies, and we have found it a useful addition to our constitution to establish local sections in different centres. Since these sections have been formed, many valuable contributions have been incorporated in the Journal of the Institution which might not have appeared there, had the opportunity of having a meeting-place in the author's neighbourhood been absent, and had there not existed an organised assembly to discuss the subject submitted by him. The local sections are growing and must, by the nature of things, increase in importance. The development of the electrical industry in the provinces must advance with greater strides than in London, where manufacturers are hampered by high local rates, and sometimes obstructive legislation, which appears to be a necessity in our large metropolis, and which is, fortunately, not so essential in smaller communities. Again, in the neighbourhood of London the cost of raw material is appreciably higher; fuel is also higher, and the charges for the transport of the finished goods to their destination handicaps the London manufacturer. These, in addition to the higher scale of wages paid, are fast driving manufacturers into the provinces. Such a migration, from a general point of view, is perhaps advantageous; but it indirectly affects the Institution in a way which is not of advantage to the central body. If the migration continues to the

same extent as took place in the case of London shipbuilding many years ago, the centre of production, so to speak, of the electrical industry will gradually gravitate northwards, and nothing but consumers will be left in the Metropolis. Many of our ablest members are already in the provinces, and it is quite a question for the Institution to consider whether the day is not fast approaching when we should extend our system of decentralisation. Is it not time that we should consider the establishing of a local section in London, similar in all respects to the local sections we have in Birmingham, Dublin, Glasgow, Leeds, Manchester, and Newcastle? In this new local section papers affecting London could be read, and be published or not in the Journal of the Institution in the same manner as papers in the other local sections are dealt with. London would continue to be the headquarters of the Institution, and Institution meetings could be held, say, four times a year. At these, papers of general interest could be contributed. If any such scheme as this were adopted, the constitution of the Council of the Institution would be somewhat affected. The Chairman and Committee of the London Local Section would, of course, be all London men, but the Institution would have a larger field from which to select its President and Council, as men who have their business in the provinces, and who cannot spare the time to attend the present numerous Council and Institution meetings, might be able to attend the less numerous meetings which would be the outcome of some such rearrangement."

While experience in Germany has not tended to minimise the interest which has been manifested in the work of the Society of German Engineers in Berlin, the activity of the local sections has done much to advance the work of the whole body, and the large membership of active engineers which has made the Society one of the most powerful in the world is undoubtedly due to this system. If such a plan works well in Germany it certainly offers possibilities both in the British Empire, and in the United States, where the wide distances which separate many of the members of professional societies from headquarters form a certain element of weakness.

The necessity for the localisation of the administration of a professional society in a metropolis is understood by all, and it would undoubtedly be well for the work of the profession if a strong centralised administration, under proper regulation, existed to direct the work of a number of societies, themselves occupying various branches of the great field of work. If, however, local members, themselves resident at a distance from the main headquarters, are to be kept interested in the work, it is desirable that they feel a closer connection with the objects and progress of the whole than can be secured merely by the receipt of an occasional volume of transactions or proceedings.

In the case of the branches of the German society, experience has demonstrated that the annual conventions, which are held away from the headquarters, are most energetically aided by the local sections in the vicinity of the meetings, and that a degree of national strength is thus obtained which could not be secured in any other manner.

It will be a matter of much interest to observe th extent to which the suggestion of Mr. Gray will bring forth fruit in the future conduct of the Institution of which he is the head, while developments in the same direction in other places may be made.

A STUDY OF CARBON VAPOR.

THE VAPORISATION OF CARBON FILAMENTS IN INCANDESCENT ELECTRIC LAMPS AT MODERATE TEMPERATURES.

M. Berthelot—Académie des Sciences.

CARBON is supposed to be one of the most infusible of elements and capable of being maintained for long periods of time in a state of incandescence without change when kept from access of oxygen. Since fusion is supposed to precede vaporisation it might seem that carbon vapor was a substance not often encountered, but as a matter of fact carbon vapor has a very practical significance.

It is well known that the bulbs of incandescent electric lamps gradually become

blackened on the inside, and the effective illuminating power is thus very materially diminished with the lapse of time, while the filament also slowly wastes away. Since these occurrences take place in the highest vacuum which it is practicable to produce and maintain, it is evident that the solid carbon of the loop must in some way be converted into vapor and redeposited upon the inner walls of the bulb. These well-known phenomena have been most carefully investigated by M. Berthelot, and in a recent communication to the French Academy, published in *Comptes Rendus*, the general results of his experiences are given.

Assuming that the carbon of the filament is actually vaporised and deposited upon the glass, M. Berthelot proceeded to examine the conditions under which the vaporisation takes place, and to discover, if possible, the state of carbon vaporised at the lowest possible temperature, comparing it with the well-known states of carbon, diamond, graphite and amorphous carbon.

In order that the idea of maintaining a moderate temperature might be met, M. Berthelot explains that he took precautions to work with carbon deposits which were formed during various periods of incandescence, at temperatures of 1,200° to 1,500° C., and to avoid those bulbs in which the filament had parted. In this latter instance there is every probability that a higher temperature had momentarily existed, introducing rapid changes, impossible of study or verification.

M. Berthelot gives the details of his chemical treatment of the carbon deposits upon the interior of selected bulbs, showing that in all cases where the comparatively low temperature had been maintained, the carbon was wholly in the amorphous state, there being no trace of either graphite or diamond. With the tests made upon each bulb there were made comparative tests of the remaining portions of the unbroken filament, which, of course, had been subjected to the same temperature for the same period of time. These filaments, in the greater number of cases, had been prepared by the pyrogeneous destruction of certain vegetable fibres. In some instances an artificial fibre of cellulose formed the base, and in all cases a brief period of high incandescence sufficed to remove all traces of hydrogen or of other gases or vapors, so that in well-made lamps no appreciable vapor of carbon existed. New filaments, examined and tested with the same care as the carbon deposits, showed no traces of graphite. A similar examination of used filaments which remained intact, and hence had not been raised to the temperature of the spark, showed again no trace of graphite, being altogether amorphous. Since it is well known that graphitic carbon is produced at temperatures existing in the electric arc, it follows that the existence of graphite bears some relation to temperature, not being produced at comparatively low temperatures of incandescence.

Carbon vapor must possess an appreciable tension at incandescent white heat, about 1,200° to 1,500° C., but this tension must be very low, since several hundred hours are required to produce a few milligrammes of condensed carbon, even in the almost perfect vacuum of the incandescent lamp bulb. Since, according to Violle, the boiling point of carbon is about 3,600° C., it follows that vapor of an appreciable tension is formed at a temperature of about 2,000° C. below the boiling point, an interval which greatly exceeds that for other bodies which possess a vapor tension.

It is hardly correct, however, to compare the vapor of carbon with that of other well-known substances, such as water, alcohol, and the like. With these the phenomena of vaporisation is a purely physical question, the substance remaining the same throughout the successive stages of solid, liquid and vapor, the changes being wholly molecular, and involving a comparatively small expenditure of energy.

Carbon, on the contrary, while being always the same chemical element, presents itself in a variety of states when in the solid condition; these states possessing very dissimilar chemical and physical properties. Each of these forms of carbon appears to have its own molecular constitution and capable of forming its own series of combinations. M. Berthelot believes that the varying properties of these varying states of carbon extend to the conditions of vaporisation, and that the action of heat proceeds according to a progressive series of condensations, the various forms of carbon representing the limits of these condensations. This view is sustained by the enormous ab-

sorption of heat necessary, this being 8 to 10 times that required for the vaporisation of water, but being possibly demanded to effect the successive dissociations of the carbon. As an analogy of the behavior of compound substances, M. Berthelot cites the fact that the boiling point of hydrogen is —252°, and of oxygen, —182°, while their combination, water boils at + 100° C. The force which maintains the molecules of hydrogen and oxygen in the gaseous state has thus diminished in an enormous proportion, corresponding to a loss of 59,000 calories at the moment of their combination to form one molecule of the vapor of water. In like manner carbonic oxide, which boils at —190°, and oxygen, boiling at —182°, form carbonic acid, which boils at —78°, there being disengaged heat equivalent to about 68,000 calories.

Throughout the various changes in carbon during vaporisation its elementary condition is assured by the permanency of its spectrum, so that the normal atoms must remain unchanged. The study which M. Berthelot has made of the behavior and production of the vapor of carbon is interesting both from a theoretical and a practical point of view, since it leads to considerations which may show why its vapor is formed so far below its boiling point;—a fact of which the explanation may lead to the discovery of methods for its control, to the practical advancement of its application in the arts.

HIGH-SPEED TOOL STEELS.

DATA AND RESULTS OF TESTS ON LATHE TOOLS AT THE MANCHESTER MUNICIPAL SCHOOL OF TECHNOLOGY.

Manchester Association of Engineers.

FOR a time after the modern high-speed steels were introduced in general shop use the question of the real gain from their use was considered to be a debatable matter. Now, however, the question is not: "Shall we use high-speed steels?" but rather: "How shall we obtain the best results from them?" Under these circumstances all the reliable data which can be obtained of actual performances are to be welcomed, as conducing to the more intelligent use of modern tools.

The tests made by Dr. Nicolson, at the Manchester Municipal School of Technology, a report upon which was presented before the Manchester Association of Engineers, contains much valuable information, and some abstract of the results will indicate the general character of the investigations.

Eight different varieties of tool steel were tested, all the trials being made upon a special electrically-driven lathe, so arranged that cutting speeds from 12 to 200 feet per minute could be obtained upon a bar of 5 feet circumference. The power delivered was measured electrically, the proportion of lost power being computed by a formula experimentally deduced from trials with a Prony brake and from a belt dynamometer. The trials were made to determine three different elements: the maximum weight of metal which could be removed per minute, the maximum area of surface machined, and the maximum cutting speed attainable. The materials worked were forged steel and cast iron, each material being used in three grades, soft, medium, and hard. The results of the trials are recorded both in tabular form and in graphical diagrams, for which reference must be had to the report, but some of the conclusions may be given here.

In the first place the term high-speed must not be considered as relating wholly to the linear speed of the material under the tool, since the real question underlying the whole matter is the increased speed at which a given piece of work can be performed. It is the amount of material which can be removed in a given time which interests the constructing engineer, since the great workshop gain lies in the ability to substitute cheap and rapid lathe work for slow and expensive forging. The much-discussed question as to the consumption of power, to which Dr. Nicolson gives consideration, is altogether of secondary value, since the power required forms an unimportant element in shop costs compared with the influence of time, especially in connection with the distribution of establishment charges. The real influence which the cutting force

has upon the study of the subject lies in its relation to the strains upon the machine tools, and in this important matter some of the conclusions reached by Dr. Nicolson are most interesting.

Broadly the conclusions obtained from the trials are as follows: The maximum amount of material is removed, not by using the maximum linear speeds, but by using the heavier feeds and cuts. Thus on soft steel, with a feed and cut both of 1/16 inch and a speed of 149 feet per minute, the amount of metal removed was 1.72 pounds per minute, while with a cut of ⅜ inch and a feed of ⅛ inch, the speed being reduced to 54 feet, the amount of metal removed rose to 7.35 pounds per minute. Similar results appear upon the different materials machined, and in general it may be stated that the relation of machining efficiency to speed shows that the highest linear speeds are not the most efficient.

Very interesting are the endurance trials, since it is often desirable to know whether a tool can be expected to last through a cut at a given rate of speed, cut, and feed. The life of the tool itself is of secondary importance, but the workman should be able to know beforehand the relation of all the working conditions in order to judge which combination of them to use for any given piece of work. The endurance trials on medium cast iron, with a cut of 3/16 inch, and a feed of 1/16 inch on a linear speed of 34 feet per minute showed that but three out of thirteen tools lasted more than one hour, and none of them held out for the proposed two-hour limit. An ordinary Mushet tool ran for an hour on the same material at a speed of 19½ feet per minute, while ordinary water-hardened tools failed in from four to nine minutes at a speed of 12 feet per minute.

The experiments confirmed what has been demonstrated elsewhere, that the resistance to cutting does not increase, and even appears to diminish, with increased cutting speeds, so that increased speeds do not necessarily involve heavier or stiffer machine tools. The heavier cuts and feeds, however, show almost proportional increase in power required, while at the same time a higher economy in power is obtained because of the greater return in useful work.

These experiments of Dr. Nicolson's supplement in a very interesting manner those of Mr. Carl Barth, mentioned elsewhere in this issue, and show how necessary some scientific study of operative conditions is in order that the maximum total efficiency of the new steels be obtained. Mr. Barth has taken the position that the working information about the steels and the various materials to be worked can be gathered and arranged so that the workman may be governed by the experience obtained and thus all the mass of accumulated shop experience with the old steels can be put aside in such a manner as to prevent it from hampering the new materials in practical use. The workman, using his special slide rule or diagram, can select at once the proper speed, feed, and cut for the work in hand, and all uncertainty is eliminated.

Much of the data gained by Dr. Nicolson will be available in the design of lathes for use with modern steels, and by choosing the speeds and feeds found to be the most useful and efficient the working stresses upon the various parts of the machine may be determined to a far higher degree of precision than has ever been practicable under former conditions. Not the least of the benefits which has resulted from the investigations is the collection of definite data suitable for use with problems in machine design, and if this point is kept in view future trials may be rendered of still greater value.

A SWISS MECHANICAL LABORATORY.

THE NEW EXPERIMENTAL ENGINEERING DEPARTMENT OF THE NATIONAL POLYTECHNIC SCHOOL AT ZÜRICH.

Schweizerische Bauzeitung.

AMONG the scientific educational institutions of Europe the Zürich Polytechnic has always held a very high place, and the names of Reuleaux, Zeuner, Clausius, and others have been most creditably followed by those of Prasil, Stodola, and their associates. Space in the main building having become inadequate, an entirely

new and independent building has been constructed, and is now in full and active service, and from a very complete account in recent issues of the *Schweizerische Bauzeitung* we abstract some account of the place and the work which is there being accomplished.

Three departments of experimental engineering are provided for in the building, these being designated as the "caloric," the "hydraulic," and the "electrical" laboratories.

The so-called "caloric" laboratory includes the appliances for the experimental study of all kinds of heat engines, as well as of refrigerating machinery, together with steam boilers and gas producers, and the necessary auxiliary apparatus. The main experimental engine, which forms the principal motor in this department, is especially interesting, since it represents the work of two of the eminent firms of engine builders in Switzerland. It is primarily arranged to be a triple-expansion horizontal engine, the high pressure and the low-pressure sections being constructed by Sulzer Brothers, of Winterthur, while the intermediate portion is from the works of Escher, Wyss & Co., of Zürich. On the shaft between the high and intermediate cylinders is placed a Thury direct-current dynamo, built by the Société de l'Industrie Electrique, of Geneva, while on the second portion of the shaft is a grooved fly-wheel pulley for use with rope transmission, and also the rotor of a polyphase generator by Brown, Boveri & Co., of Baden. The two portions of the shaft are connected by friction couplings, so that either can be operated independently, in connection with the fly wheel. The three cylinders are all provided with different varieties of valve gear, the high-pressure cylinder having the standard Sulzer poppett-valve system, controlled by a Porter governor. The intermediate cylinder is fitted with corliss valves, operated by the Frikart valve gear, having two eccentrics, so that the cut-off may be varied between 0 and 70 per cent., without affecting the compression. The low-pressure cylinder, while fitted with Sulzer valves, has the modified valve gear of Radovanovic, permitting variable compression, this also being provided with an inertia governor by Zabel & Co.

It will be seen that this interesting machine represents the work of a number of the most noted makers of Switzerland, and that its flexibility permits of a great variety of investigations upon the action of steam to be made. Thus, the cylinders may be operated as independent simple engines, or as compound engines in two combinations. The low-pressure cylinder can also have its valve gear reversed, and a supply of cooling water run through the steam jacket, in which case it is available as an air-compressor with mechanically operated valves, being driven by the other two cylinders. Any one of the three governors may be connected to any of the valve-gears, so that their action may be compared under various conditions.

A number of smaller steam engines enable the work of this principal machine to be supplemented in an effective manner, and a great variety of experimental research work is here performed.

Besides the reciprocating steam engines the laboratory is provided with steam turbines, upon which Professor Stodola has made some most important original investigations, together with gas engines, refrigerating machines, pumps, condensers, and the necessary machine tools to enable the special fitting and connections to be made for any original experimental work.

The hydraulic section of the laboratory, while well equipped and provided with means for numerous original investigations, lacks the great advantage which accompanies the presence of a natural source of water power. The situation of the building, upon the hill above the older portion of the city of Zürich, deprives it of this advantage, but an ample provision of water tanks enables the steam-power section to employ its energy in driving the pumping machinery to maintain the water supply, and thus the two departments work together.

By the combination of tanks, centrifugal pumps, weirs, and general hydraulic machinery this laboratory has been made very complete for the conduct of the more refined experimental researches in hydraulics, and under the skilled supervision of Professor Prasil, some valuable original work has been done in addition to the regular routine of instruction. Among these may be noted experiments on water jets on high-pressure centrifugal pumps, on compound

turbines, and similar work, the whole contributing to original knowledge, as well as forming most effective material for instruction.

With such a complete mechanical laboratory, in such skilful hands the reputation of the Zürich Polytechnic cannot fail to be maintained at the high standard which has attended its career in the past, and to this standard institution, as well as to the larger, but not higher Charlottenburg the attention of those interested in the advancement of technical education should be directed. Any one who has examined the nature of the work which is done at such institutions cannot fail to realize that young men who have been through such practical and scientific investigations must be far more valuable in the manufacturing and engineering establishment after even a few months of shop experience that the brightest boy who has ground through the old course of apprenticeship. If such training does not conduce to money value, and still more to national progress, the difficulty lies, not with the students and not with the system of education, but with the employers, with the statesmen, and with the industrial conditions which fail to use the opportunities which the educators are preparing for them.

This whole question of laboratory training for the engineer has been discussed again and again, but the fact that the great educational institutions continue to enlarge and extend their facilities in this direction shows very clearly the opinion of the foremost technical instructors. That this should be so is wholly in accordance with the development of modern engineering methods. The skilled workman must always be in demand, and there is no reason for fear that work will not remain for him to do, but the whole tendency of the times in engineering work is to consider each large problem anew, and to devise means for doing it as fully as may be by the methods best adapted for the special case. To attack such questions intelligently and to treat them with the broad judgment necessary for success ordinary methods of training, whether in the class or lecture room or at the workbench, will not suffice. The student must be obliged to make independent investigations on his own account. He must learn to weigh a problem and decide for himself how he will attack it, and he should have his methods and results so checked and supervised that he shall realize that his work must be honest and sincere.

For such training two things are essential; the place in which to do the work, and the instructors under whose intelligent and watchful care the work shall be done. The place includes the mechanical laboratory, an excellent example of which is seen in the new structure at Zürich, while the instructors must be found, and fortunate is the educational institution which finds them. Here again appears one of the important advantages of laboratory work in engineering. When the professor is obliged to go into the details of original research with his pupils there is no room for the pompous mystery with which the old-time teacher often successfully concealed his incompetence. Lectures may be prepared from text books, and examinations may be held under rules framed entirely from the instructor's side of the game, but when the laboratory work begins the professor is as much upon his trial as is the student, and there is no one more prompt to see any evidence of weakness or uncertainty than this same student, should occasion arise. In the mechanical laboratory all shams and deceptions must be cast aside, just as they disappear in the practical work of daily life which follows the school, and not the least of the benefits of laboratory instruction in engineering is the introduction which it thus forms to the coming occupations of the students.

There is small doubt that the value of the technical school will come to be largely judged by the facilities which it offers for practical laboratory work of a high class, and under such a test the Zürich Polytechnic will assuredly retain the place which it has always held in the past. Such an institution can always make its own record by the character of original research work which it undertakes, and by the contributions to knowledge in the department of science to which it belongs.

THE ENGINEERING INDEX

THE ENGINEERING INDEX IS THE KEYSTONE OF APPLIED SCIENCE"

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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CIVIL ENGINEERING

Arch.

A Concrete Arch Bridge Near Mechanicsville, N. Y. Illustrated description of a three-arch highway bridge. 600 w. Eng News—Nov. 5, 1903. No. 58863.

Bridge Repairs.

The Kansas City Flow-Line Bridge Repairs. J. A. Waddell. Illustrated detailed description of repairs made to the bridge over the Kaw River that carries the pipes for the water supply of Kansas City, which was badly damaged by the recent flood. 6000 w. Eng Rec—Oct. 31, 1903. No. 58761.

Cantilever.

The Reconstruction of the Frans Bridge (Reconstruction du Pont du Frans). Illustrated description of the new Cantilever bridge across the river Saône at Villefranche, replacing the former suspension bridge. 2000 w. 1 plate. Génie Civil—Oct. 31, 1903. No. 59112 D.

Collision.

A Collision with a Swing Bridge at Toledo, O. R. G. Manning. Illustrations showing the damage done, with account of the accident. 700 w. Eng News—Nov. 26, 1903. No. 59257.

We supply copies of these articles. See page 637.

Concrete Arch.

Concrete Bridge Over the Big Muddy River; Illinois Central R. R. H. W. Parkhurst. Illustrated detailed description of a bridge having three elliptical arches, each of 140 ft. clear span and 30 ft. rise above the springing lines. 6000 w. Eng News—Nov. 12, 1903. No. 58975.

Floor Construction.

The Protection of Steel in Ballasted Floor Bridges. An illustrated article giving the practice of different railways in regard to solid floor construction. 3800 w. Eng News—Nov. 12, 1903. No. 58978.

Loadings.

Loadings for Railroad Bridges. Extracts from a discussion at the June meeting of the Am. Soc. of Civ. Engrs., with editorial. 4000 w. R R Gaz—Nov. 20, 1903. No. 59218.

Railway Bridge.

Erection of the Grand Rapids Bridge. Illustrated description of the erection of a single track bridge with seven 175-ft. through Pratt truss pin-connected spans and two 50-ft. plate-girder deck spans. 1300 w. Eng Rec—Nov. 7, 1903. No. 58840.

Reinforced Concrete.

Armoured Concrete Foot-Bridge at Toulouse. Illustrates and describes the novel features of a bridge having a span of 139 ft. 1200 w. Engr, Lond—Nov. 13, 1903. No. 59082 A.

Short-Span.

Standard Short-Span Bridges on the Atchison, Topeka & Santa Fe Railway. Illustrates and describes the standard designs for single track structures up to spans of 106 ft. 2700 w. Eng Rec—Nov. 14, 1903. No. 58962.

Specifications.

A Comparison of the Requirements of Recent Railway Bridge Specifications. A. H. Heller. Gives a table showing a summary of such requirements as depend mostly on the engineer's judgment. Also much valuable information. 4000 w. Eng News—Nov. 19, 1903. No. 59022.

Suspension.

Comparative Eye-Bar and Wire Cable Designs for a Highway Bridge Over the Rhine at Cologne. Illustrates and describes two proposed designs for a suspension bridge. 1000 w. R R Gaz—Nov. 20, 1903. No. 59216.

Swing Bridge.

An American Bridge Built of German Steel and Launched at a Shipyard. P. S. Hildreth. A statement of the conditions and explanation of interesting features involved in the construction of a swing bridge at Fore River, Mass. Ill. 800 w. Eng News—Nov. 19, 1903. No. 59025.

CANALS, RIVERS AND HARBORS.

Canal Haulage.

See Electrical Engineering, Power Applications.

Dams.

A Hollow Concrete-Steel Dam at Theresa, N. Y. Sectional drawing photographs and brief description of a dam of reinforced concrete. 450 w. Eng News—Nov. 5, 1903. No. 58861.

Review of the Report of the Charles River Dam Commission. Leonard Metcalf. Substance of the very interesting report of the Massachusetts Commission. 5000 w. Tech Rev—Oct., 1903. No. 59034 C.

Dredge.

Combined Suction and Bucket Dredger. Illustrated description of a high-powered dredger for the port of Montevideo. 400 w. Engr, Lond—Nov. 13, 1903. No. 59081 A.

Dredging.

A Desirable Method of Dredging Channels Through River Bars. S. Maximoff. A short description of the present conditions of river navigation in Russia and of the Government's dredging fleet, with detailed description of method proposed by the writer. Ill. 4300 w. Pro Am Soc of Civ Engrs—Oct., 1903. No. 58705 E.

Dry-Dock.

The Carena Dry-Dock, Argentine Republic. Describes a dock recently finished, proportioned to receive the largest ships yet built. Ill. 1200 w. Eng Rec—Nov. 14, 1903. No. 58956.

Mississippi.

The Levee Theory on the Mississippi River. Continued discussion of whether the levee theory is justified by experience. 9500 w. Pro Am Soc of Civ Engrs—Oct., 1903. No. 58710 E.

CONSTRUCTION.

Apartment Hotels.

The Apartment Hotel in New York. Reginald Pelham Bolton. An illustrated description of the "Ansonia" which contains 340 suites, comprising 1600 rooms and 345 bath-rooms. 2800 w. Cassier's Mag—Nov., 1903. No. 58893 B.

Beams.

Some Applications of the Principles of Least Work. (Einige Anwendungen des Satzes der Kleinsten Formänderungsarbeit). Charles Abeles. A mathematical investigation of the distribution of stresses for various loadings of beams. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 30, 1903. No. 59122 D.

We supply copies of these articles. See page 637.

Building Construction.

The Pabst Hotel and Majestic Theater. Illustrated detailed description of a four-story, steel-cage, fireproof building recently erected in New York. 2000 w. Eng Rec—Nov. 7, 1903. No. 58839.

Concrete Masonry.

Concrete Masonry on the Lu Han Railway. Extract from a paper by Thomas J. Bourne, read before the Inst. of Civ. Engrs. of Great Britain, describing some interesting work in China. 000 w. R R Gaz—Nov. 6, 1903. No. 58873.

Cribs.

Holding Power of Ballast in Timber Cribs. An account of experiments made at Duluth, Minn., and described in the Report of the Chief of Engineers, U. S. A., for 1902. 1000 w. Eng Rec—Nov. 7, 1903. No. 58841.

Falsework.

Falsework for Rocky Bottoms in Rapid Currents. From the report of the committee of the Bridges and Buildings Assn. Illustrations with brief descriptions of designs where piles cannot be driven. 1000 w. R R Gaz—Oct. 30, 1903. No. 58784.

Foundations.

Construction with Compressed Air (Construction par l'Air Comprimé). A description of the pneumatic process employed in the construction of the foundations of the new dry docks at the port of Kiel. 1800 w. 1 plate. Génie Civil—Oct. 24, 1903. No. 59111 D.

Pile Sinking.

Machine for Sinking Screw Piles. An illustrated description of the apparatus which has been designed for sinking the piles upon which the tunnels of Pennsylvania R. R. will rest. 800 w. Ir Age—Nov. 12, 1903. No. 58856.

Roads.

Maryland Road Specifications. Extracts from specifications for the construction of macadam and telford roads, giving the essential features. 1200 w. Eng Rec—Nov. 7, 1903. No. 58843.

Tunnels.

Hudson River Tunnel of the New York & New Jersey Railroad. Outlines the past history of this work and an account of the resumed work, giving drawings. 1800 w. R R Gaz—Nov. 27, 1903. No. 59263.

Improvements in Tunnel-Boring Practice in London for Deep-Level Railroads. Brief description of methods employed in tunneling beneath the River Thames. 1800 w. Sci Am—Nov. 21, 1903. No. 59028.

Manhattan and Weehawken Shafts of the Pennsylvania Railroad Tunnels under the North River. Illustrations with brief account of the work. 1200 w. Eng Rec—Nov. 14. 1903. No. 58963.

The Brooklyn Tunnel of the New York Rapid Transit Railroad. Illustrated description of details and progress of the work on the tunnel from the Battery, New York, to Brooklyn. 1800 w. Eng Rec—Oct. 31, 1903. No. 58764.

The Construction of the East Boston Tunnel of the Boston Subway System. Robert H. Farwell. Interesting information in regard to the material encountered, construction work, etc. Ill. 3700 w. Eng Rec—Nov. 7, 1903. Serial. 1st part. No. 58838.

The General Problem of Tunneling under Rivers. Editorial on methods of construction, requirements, etc. 1200 w. Eng Rec—Oct. 31, 1903. No. 58759.

The Pennsylvania Railroad Tunnel Under New York City. General plan of this great undertaking, with four insets. 2500 w. Ry Age—Oct. 30, 1903. No. 58750.

Walls.

A New Type of Reinforced Hollow Tile Wall Construction. Illustrated description of walls for mill buildings made of hollow tiles bonded with strap iron—the "Phoenix" hollow tile wall. 600 w. Eng News—Nov. 5, 1903. No. 58871.

MATERIALS.

Cement Mortar.

Effect of Clay and Loam on Cement Mortar. C. E. Sherman. An account of bridge construction in Yellowstone National Park, describing the material used, and giving results of tests made. 2000 w. Eng News—Nov. 19, 1903. No. 59021.

Cement Plant.

The Plant of the Buckhorn Portland Cement Co. Richard L. Humphrey. Illustrates and describes an interesting plant in W. Va., built on the side of the mountain from which the raw material is obtained. 3000 w. Eng News—Nov. 5, 1903. No. 58864.

Concrete.

Impervious Concrete. Sanford E. Thompson. A contribution to the discussion as to whether it is possible to make a concrete which will be impervious to water. 1100 w. Pro Am Soc of Civ Engrs—Oct., 1903. No. 58706 E.

Flooring.

New Flooring Material. Illustrates and describes a system of concrete flooring, consisting of hollow tubes of mortar and iron. The Siegwart beam. 900 w. U S Cons Repts, No. 1802—Nov. 16, 1903. No. 58988 D.

Reinforced Concrete.

The Determination of the Rectangular Section of a Reinforced-Concrete Beam

We supply copies of these articles. See page 637.

(Bestimmung des Rechbeckigen Querschnittes eines Armierten Betonträgers). G. Ramisch. A mathematical discussion deriving general equations for beams of reinforced concrete, with practical applications. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 6, 1903. No. 59123 D.

See Civil Engineering, Bridges.

See Civil Engineering, Canals, Rivers and Harbors.

See Civil Engineering, Water Supply.

Soapstone.

Norwegian Soapstone. An illustrated article describing this stone, and the quarries. It is valued as a building stone. 1800 w. Quarry—Nov., 1903. No. 58904 A.

Stone.

Analyses and Particulars of British Stone. The first of a series of articles giving particulars and tests. 1000 w. Quarry—Nov., 1903. Serial. 1st part. No. 58905 A.

Timber.

Fungous Diseases of Forest Trees. Hermann von Schrenk. An explanation of how trees are infected, the rate of decay, treatment, remedies, etc. Ill. 6000 w. Bul Internat Ry Cong—Oct., 1903. No. 58720 E.

MEASUREMENT.

Surveying.

Recent Rapid Base-Line Measurements, Precise Leveling, and Triangulation. A. L. Baldwin. An illustrated article giving an account of the work of the U. S. Coast and Geodetic Survey. Also discussion. 3700 w. Pro Engrs' Club of Phila—Oct., 1903. No. 58702 D.

Topographical Surveying. W. C. Bunnel, Jr. Notes showing what has been done, and the results obtained. Discussion. 5000 w. Jour W Soc of Engrs—Oct., 1903. No. 59275 D.

MUNICIPAL.

Garbage.

The Latest Garbage Disposal Statistics. Editorial review of a paper by C. E. A. Winslow and P. Hansen, presented at the Washington meeting of the Am. Pub. Health Assn. 2000 w. Eng News—Nov. 5, 1903. No. 58865.

New Orleans.

Sewerage and Plumbing in New Orleans. Editorial on the system employed. 1500 w. Eng Rec—Nov. 14, 1903. No. 58954.

Pavements.

The Development of the Kreodone Block Pavement. P. C. Reilly. Reports experience with wood block pavements in Indianapolis, and the recent improvements in material used, claiming the Kreodone block to wear well, and to be indifferent to wet, dry, heat or cold. 2500 w. Munic Engng—Nov., 1903. No. 59036 C.

Wood Paving Specifications in Greater New York. F. A. Kummer. Gives the specifications for streets, and also for bridge floors. 3800 w. Munic Engng—Nov., 1903. No. 59035 C.

Sewage.

Sewage Disposal at Hebden Bridge. Illustrates and describes a new installation in which chemical precipitation forms the principal feature. 1500 w. Engr, Lond—Oct. 23, 1903. No. 58737 A.

Liquid Sewage (Vloeibar Afval). D. J. Sanches. A comparison of the Liernur pneumatic system of sewage removal with the liquid bacterial purification method. 4000 w. De Ingenieur—Oct. 31, 1903. No. 59153 D.

Winter Treatment of Sewage Beds. Information from several sewage plants in various parts of the United States which have been successfully operated. Ill. 1800 w. Eng Rec—Nov. 14, 1903. No. 58959.

Sewers.

Construction of the Sixty-fourth Street Sewer Tunnel, Brooklyn. An illustrated description of a special arch-timber method of tunneling. 3200 w. Eng Rec—Nov. 21, 1903. Serial. 1st part. No. 59204.

Methods and Cost of Constructing a Concrete Sewer Having a Brick Arch, at Medford, Mass. Description from report of William G. Taylor, with illustrations. 1000 w. Eng News—Nov. 19, 1903. No. 59027.

Perviousness of Sewers. Abstract of a paper read by Prof. A. Prescott Folwell at the convention of the Am. Soc. of Munic. Imp. Gives reports of measurements made at several places, and briefly discusses the advantages and disadvantages of infiltration. 2800 w. Eng Rec—Nov. 7, 1903. No. 58842.

Tunneling for a Sewer Beneath the Cochituate Aqueduct. J. H. Kimball. Describes a difficult piece of work at Newton Highlands. 800 w. Eng Rec—Nov. 14, 1903. No. 58957.

WATER SUPPLY.

California.

Southern California's Mountain Water Company's Reservoirs, Dams and Pipe Lines. An illustrated description of portions of extensive development schemes, including dams, reservoirs, flumes and pipe lines. 3000 w. Eng Rec—Nov. 14, 1903. No. 58958.

Conduits.

The Construction of the Sixty-Inch Reinforced Conduits of Newark, N. J. Mor-

We supply copies of these articles. See page 637.

ris R. Sherrerd. Brief illustrated description of monolithic work. 1500 w. Munic Engng—Nov., 1903. No. 59037 C.

Wrought-Steel Conduits for Gravitation and Pressure Water Supply. Herbert Fetherston Lloyd. From the Pro. of the Inst. of Civ. Engrs. Discusses the design, manufacture, and erection of water pipes, siphons, culverts, and flumes, of varying cross section, constructed of mild steel. Ill. 5400 w. Prac Engr—Oct. 23, 1903. No. 58717 A.

Electric Plant.

The Electric Water Supply Plant of the City of Urfahr on the Danube (Wasserversorgung der Stadt Urfahr a. D. mit Elektrischem Betrieb). A. Oelwein. Describing the wells, reservoirs and electric pumping plant for the supply of a city of about 8,000 population. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 30, 1903. No. 59121 D.

Filtration.

A Remarkable Contract for Engineering Services and Water Filtration Patents. Abstract of the contract for the city of Wilmington, Del., with editorial comment. 2500 w. Eng News—Nov. 26, 1903. No. 59256.

A Small Open Sand Filter at Reading, Pa. Description, with illustrations, of the Egelman filter plant. 1600 w. Eng Rec—Nov. 7, 1903. No. 58844.

Filtration at Alexandria. An illustrated description of this plant in Egypt. 2500 w. Fire & Water—Nov. 21, 1903. No. 59067.

The Lawrence Filter. M. F. Collins. Illustrated description of the filter and its method of operation, and certain features of the results. 2500 w. Jour N Eng W Wks Assn—Sept., 1903. No. 59284 F.

Independent Supply.

The Water Supply of the Lackawanna Steel Works. Illustrates and describes a supply drawn directly from Lake Erie without filtration, to be used for industrial and mechanical purposes. May require daily from 70,000,000 to 75,000,000 gallons. 2400 w. Eng Rec—Nov. 21, 1903. No. 59205.

Irrigation.

Irrigation in South Africa. Discusses in detail the state control of rivers and other sources of supply, and the advantages gained by easily constructed devices for storing and distributing the natural flow. 5000 w. Engr, Lond—Nov. 13, 1903. No. 59079 A.

South African Irrigation. Augustine W. Wright. Continued discussion of paper by Francis Robert Johnson. 1600 w. Pro Am Soc of Civ Engrs—Oct., 1903. No. 58709 E.

Metric System.

The Folly of Reckoning by Gallons, Which Differ Widely in Canada and the United States, While All Countries Have Identical Liters and Cubic Meters. Frederick Brooks. Urging the use of metric system in measuring water consumed. 3300 w. Jour N Eng W Wks Assn—Sept., 1903. No. 59281 F.

Montreal.

History and Description of the Montreal Water Works. George Janin. A brief history and description of the aqueduct system. 3300 w. Ill. Jour N Eng W Wks Assn—Sept., 1903. No. 59282 F.

Service Boxes of the Montreal Water Works. T. W. Lesage. Illustrates and describes various types that have been tried, the difficulties due to climate and other conditions, and the present type. 1100 w. Jour N Eng W Wks Assn—Sept., 1903. No. 59283 F.

New York.

American Water Works. Charles Prelini. Gives a statement of conditions affecting the water supplies of America, reviewing briefly the general history of the water problem, with special reference to the Croton Aqueduct, and giving a detailed account of the actual state of the water supply of New York City. 5400 w. Trac & Trans—Nov., 1903. Serial. 1st part. No. 58898 E.

Pipes.

Care of Pipe and Conduits. James E. Maxwell. Calls attention to troubles due to the improper laying of pipes, and other conditions. 1500 w. Fire & Water—Nov. 14, 1903. No. 58934.

Reservoirs.

Amsterdam Reservoir Construction. Illustrated description of the new Glenwild storage reservoir belonging to the system of Amsterdam, N. Y. 2000 w. Fire & Water. Nov. 7, 1903. Serial. 1st part. No. 58785.

Covering an Old Reservoir at Brookline, Mass. F. I. Winslow. Describes the construction of a groined arch concrete roof. 800 w. Eng News—Nov. 12, 1903. No. 58977.

St. Louis.

Changes in the Settling Basins and the New Hydraulic Dredge of the St. Louis Water-Works. E. E. Wall. An illustrated account of interesting changes being made to substitute continuous sedimentation for the fill and draw method. 1300 w. Eng News—Nov. 26, 1903. No. 59259.

Statistics.

Water-Works Statistics for the Year 1902, in Form Adopted by the New Eng-

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land Water-Works Association. Compiled by Charles W. Sherman. 1500 w. Jour N Eng W Works Assn—Sept., 1903. No. 59280 F.

Wells.

The California or "Stove-Pipe" Method of Well Construction for Water Supply. Charles S. Slichter. Illustrated description of this type of well and method of construction. 2000 w. Eng News—Nov. 12, 1903. No. 58976.

MISCELLANY.

Engineering Principles.

The Borderland of Biology and Engineering: Exemplifications of Engineering Principles in Living Structures. Henry Leffmann. An interesting study. 2000 w. Pro Engrs' Club of Phila—Oct., 1903. No. 58704 D.

Landslide.

The Railway Landslide at Cleveland. An illustrated article describing the destruction of railways and buildings by a slide along the lake front. 1200 w. Eng Rec—Nov. 14, 1903. No. 58955.

Reclamation.

The United States Reclamation Service in the Arid West. F. H. Newell. A statement of the proposed work of reclaiming the arid lands and making possible their settlement. 1200 w. Eng News—Nov. 26, 1903. No. 59260.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cable Laying.

Cable Laying in Manila and a Trip Around the World. Lewis G. Martin. An illustrated account of a trip to lay land cables for the Commercial Pacific Cable Co. 1800 w. Elec Rev, N Y—Nov. 14, 1903. No. 58949.

Cables.

Practical Examples with the Calculator Board. Edward Raymond-Barker. Notes for submarine cable staffs giving a series of practical examples worked out by use of the calculator board. 1400 w. Elec Rev, Lond—Oct. 23, 1903. Serial. 1st part. No. 58724 A.

Cable Steamer.

See Marine and Naval Engineering.

Longitude.

The Determination of the Longitude of Honolulu, 1555-1903. John F. Hayford. An account of the recent determination by the telegraphic method of the difference of longitude of San Francisco and Honolulu through the new Pacific Cable. 1700 w. Eng News—Nov. 5, 1903. No. 58866.

Printing Telegraph.

Steltje's Type-Printing Telegraph. Brief description, with illustration. No batteries are required, and the message is printed automatically at both ends of the line. 800 w. Sci Am—Nov. 7, 1903. No. 58886.

Secrecy.

Connections for Maintaining Secrecy in Communication (Schaltung zur Sicherung des Gesprächsgeheimnisses). J. E. Salzer. Describing methods of preventing private telephone communications from being overheard by exchange operators or others. 2500 w. Elektrotech Zeitschr—Oct. 22, 1903. No. 59140 B.

Space Telegraphy.

Some Wireless Telegraph Patents. Gives illustrated descriptions of recent patents granted in Great Britain. 2500 w. Elect'n, Lond—Nov. 6, 1903. Serial. 1st part. No. 58996 A.

The International Preliminary Conference to Formulate Regulations Governing Wireless Telegraphy. John I. Waterbury. Outlines the circumstances which led to this conference, and the work accomplished. 4500 w. N Am Rev—Nov., 1903. No. 58812 D.

The Relative Reliability of Wireless and Wire Telegraph Systems. Reginald A. Fessenden. Reports results of tests made during the past four years. 1500 w. Elec Wld & Engr—Nov. 14, 1903. No. 58971.

Wireless Telegraphy and Agriculture. Emile Guarini. An account of applications of wireless telegraphy being made in France. Ill. 1200 w. Elec, N Y—Nov. 4, 1903. No. 58920.

Telephony.

Municipal Telephones. J. F. Hemenway. Reports the successful operation in European and English cities at much lower rates than in America. 2800 w. Munic Jour & Engr—Nov., 1903. No. 58878 C.

Swansea Municipal Telephones. Outlines the history of this undertaking, giving details of the work. Ill. 800 w. Elec Engr, Lond—Nov. 13, 1903. No. 59090 A.

Transposition of Telephone Lines: Cross-Talk and Induction. Reviews a paper by Frank F. Fowle, read at the New Orleans meeting of the Assn. of Ry. Tel. Supts. on line disturbances arising from reactance and leakage. 2800 w. Elec Wld & Engr—Nov. 21, 1903. No. 59222.

Time Switch.

An Electric Time Switch (Ueber einen

We supply copies of these articles. See page 637.

Elektrischen Zeitschalter). Hans Carl Steidle. Describing a device for repeating any predetermined series of interruptions after a determinate time interval. 2500 w. Elektrotech Zeitschr—Oct. 15, 1903. No. 59137 B.

DISTRIBUTION.

Rotary Converters.

Some Notes on the Hunting of Rotary Converters. Clarence P. Fowler. Notes some of the most important causes, and means of preventing. 800 w. Am Elect'n —Nov., 1903. No. 58884.

Three-Phase.

Distribution of Current in Three-Phase Systems. F. Hardie Jeannin. Gives analysis of method of connecting up ammeters. 1400 w. Elec Wld & Engr—Nov. 14, 1903. No. 58969.

Three-Wire.

Notes on Certain Three-Wire Systems. Charles T. Mosman. Read before the Ohio Elec. Lgt. Assn. A discussion of the new conditions in electrical developments and points that should be considered. Thinks there is little justification for extensive use of the 500-volt three wire system in the United States. Considers desirable arrangements. 2000 w. Elec Rev, N Y—Oct. 31, 1903. No. 58768.

Transformers.

Construction of a Small Variable Voltage Transformer. W. B. Roberts. Illustrates a design having a maximum capacity of about 80 watts and capable of furnishing a secondary pressure from zero to about 5 volts. 2000 w. Am Elect'n—Nov. 5, 1903. No. 58883.

ELECTRO-CHEMISTRY.

Accumulators.

Development of the Light Accumulator Since 1900. H. L. Joly. Illustrates and describes types appearing since the date named, discussing tests made. 3600 w. Electro-Chem & Met—Oct., 1903. No. 59278 D.

Faure Type Accumulators. Abstract from a paper by M. Levazzari, read before the Second International Automobile Congress. Gives a résumé of storage battery conditions in France, limited to the light type of accumulators with pasted plates. 3500 w. Sci Am Sup—Nov. 14, 1903. No. 58985.

Antimony.

Electrolytic Process for Extracting Antimony from Its Sulphureted Ores. Translated from *La Revue des Produits Chimiques.* Describes the process, the object being to attract the antimony to one pole and the sulphur to the other. 1500 w. Sci Am Sup—Nov. 14, 1903. No. 58986.

Battery.

The Coal Battery. Hugo Jone. An illustrated description of an invention of the writer, which he claims will give more electrical energy than is obtainable by means of the dynamo, in combination with a steam, or gas engine. 4500 w. W Elect'n—Nov. 21, 1903. No. 59070.

Bleaching.

Electrical Bleaching (Elektrische Bleiche). A description of the Haas & Oettee process for the electrolytic production of bleaching solutions. 1800 w. Elektrochemische Zeitschr—Nov., 1903. No. 59151 G.

Carbon Bisulphide.

The Manufacture of Carbon Bisulphide in the Electric Furnace at Penn Yan, N.Y., U. S. A. Illustrates and describes the furnace used. 1000 w. Electro-Chem & Met —Oct., 1903. No. 59279 D.

Chloride Solutions.

Historical Sketch of the Development in the Production of Copper, Nickel, and Zinc from Chloride Solutions. William Koehler. Ill. 2000 w. Electro Chem Ind —Nov., 1903. Serial. 1st part. No. 58930 C.

Copper.

See Mining and Metallurgy.

Electrolysis.

The Present Position of the Theory of Electrolysis. Principally a discussion of the dissociation theory. 3300 w. Engng—Nov. 13, 1903. No. 59073 A.

Electro-Metallurgy.

Electro-Metallurgy in France. Illustrated article describing the works of the Société Electro-Metallurgique Française. 2500 w. Trac & Trans—Nov., 1903. No. 58901 E.

Experimental Studies.

Laboratory Notes for Students in Practical Electrochemistry. S. A. Tucker. Gives an account of experimental work at Columbia University. 3000 w. Sch of Mines Qr—July, 1903. No. 59293 D.

Ferro Metals.

A Brief Study of the Ferro Metals and Their Electrical Manufacture. Auguste J. Rossi. Describes the methods followed in the manufacture of ferro metals in general, and specially gives the results of four years study of ferro-titanium. 7000 w. Ir Age —Nov. 12, 1903. No. 58858.

Galvanizing.

The Galvanic Deposition of Zinc upon Iron (Galvanische Zinkniederschläge auf Eisen). O. Gabran. Giving data and results with various solutions at different current densities. 1800 w. Electrotech Zeitschr—Nov. 12, 1903. No. 59149 B.

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Investigations.

The Behavior of Cerium, Lanthanum, Neodymium, Praseodymium, Thorium, and Zirconium Toward Organic Bases. Burt Laws Hartwell. A report of investigations made in the hope of finding an organic base that would lead to quantitative separations. 2500 w. Am Gas Lgt Jour—Nov. 23, 1903. No. 59213.

Water.

Apparatus for the Electrolysis of Water (Vorrichtungen zur Elektrolyse des Wassers). L. Tiersot. Describing the apparatus of Siemens & Halske for decomposing water on a large scale by the electric current. 1200 w. Elektrochemische Zeitschr—Nov., 1903. No. 59150 G.

ELECTRO-PHYSICS.

Conductivity.

Some Experiments on the Electrical Conductivity of Atmospheric Air. J. C. McLennan and E. F. Burton. Read before the Am. Phys. Soc. An account of experimental investigations, showing the effect of different metals and other influences. 2200 w. Sci Am Sup—Nov. 7, 1903. No. 58888.

The Electrical Conductivity of Commercial Copper. Lawrence Addicks. Considers the physical characteristics and their influence upon the conductivity; also the chemical impurities. 1500 w. Trans Am Inst of Elec Engrs—Nov. 20, 1903. No. 59300 D.

Discharges

Static Discharges in Electric Circuits. Percy H. Thomas. Considers the character of wave motion and the laws involved and treats by analogy the effects of waves in electric circuits. 3500 w. Jour Fr Inst—Nov., 1903. Serial. 1st part. No. 58913 D.

Electrodes.

Standard Electrodes. Woolsey McA. Johnson. Discusses the various standard electrodes from several points of view. 2500 w. Electro Chem Ind—Nov., 1903. No. 58929 C.

Electrostatics.

Notes on Electrostatics, Treated Opsigraphically. Hugh Erat Harrison. The present article is introductory and explanatory. 1700 w. Elec Times—Nov. 12, 1903. Serial. 1st part. No. 59068 A.

Indicator.

The Cathode Ray Alternating Current Wave Indicator. Harris J. Ryan. Describes a method of using the Braun type of cathode ray tube as an alternating current wave indicator. Discussion. Ill. 4500 w. Trans Am Inst of Elec Engrs—Oct., 1903. No. 59287 D.

Radio-Activity.

On the Intensely Penetrating Rays of Radium. R. J. Strutt. Communicated to the Royal Soc. A report of investigations. 600 w. Sci Am Sup—Nov. 7, 1903 No. 58890.

Radio-Activity. Edward A. Partridge. and Robert H. Bradbury. Reviews the work of the Curies and other investigators, discussing the effects of emanations from radio-active bodies. 3500 w. Jour Fr Inst—Nov., 1903. No. 58911 D.

Radio-Activity. Frederick Soddy. The first of a series of articles based on lectures being delivered in London, to be revised and amplified and issued in book form. 3800 w. Elect'n, Lond—Oct. 23, 1903. Serial. 1st part. No. 58728 A.

Radium and Its Wonders. George F. Kunz. An interesting review of the history of this remarkable substance, its source, properties, action on organic bodies, value, etc. 6500 w. Rev of Revs—Nov., 1903. No. 58692 C.

GENERATING STATIONS.

Armature Cores.

The Factors Which Affect the Energy Losses in Armature Cores. J. Walter Esterline and C. E. Reid. An account of investigations with illustrated description of apparatus used. Also discussion. 6000 w. Trans Am Inst of Elec Engrs—Oct., 1903. No. 59285 D.

Commutators.

Commutator Brushes Running under Oil (Unter Oel Laufende Kommutatorbürsten). M. Osnos. Giving designs by use of which oil insulation may be used for commutators, with reduction of losses and avoidance of sparking. 1800 w. Zeit für Elektrotechnik—Oct. 11, 1903. No. 59155 D.

Compounding.

The Compounding of Alternators (Compoundierung von Wechselstrom-Generatoren). A. Heyland. Giving an application of the vector analysis to the problem of compounding with especial reference to the writer's improved system of synchronous compounding. 2500 w. Elektrotech Zeitschr—Nov. 5, 1903. No. 59145 B.

Copenhagen.

The Ostre Electric Station at Copenhagen (Das Ostre Elektricitätswerk in Kopenhagen). C. Hentzen. Illustrated description of a large generating station in the Danish capital. 3500 w. Elektrotech Zeitschr—Oct. 29, 1903. No. 59141 B.

Dynamo Design.

A Basis for the Comparison of Dynamo Designs. W. B. Esson. Critical remarks

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on an article by H. M. Hobart. 1100 w. Elect'n, Lond—Oct. 23, 1903. No. 58731 A.

Dynamos and Motors, Showing the Various Windings and Wire Connections. William H. Kritzer. Illustrated article describing the most important systems suitable for mining plants. 1400 w. Min & Sci Pr—Nov. 7, 1903. Serial. 1st part. No. 58946.

Formulas for the Design of Electrical Machinery (Formeln zum Entwerfen Elektrischer Maschinen). A Sengel. Deriving a number of convenient working formulas for use in designing dynamos, motors and transformers. 3000 w. Elektrotech Zeitschr—Oct. 29, 1903. No. 59142 B.

Some Practical Points in the Design of Direct-Current Dynamo-Electric Machines. Cecil P. Poole. Describes a plan of designing in the hope that it may be considered a slight advance on the practice usually followed. 3700 w. Jour Fr Inst—Nov., 1903. No. 58912 D.

Wiring Small Dynamos. An article in two parts, written for the guidance of the laymen. Ill. 3300 w. Aust Min Stand—Oct. 8 & 15, 1903. No. 58992 B.

Dublin.

Dublin Three-Phase Central Station. Illustrated description of an electric lighting system which employs the four-wire, three-phase distributing system. 2500 w. Elec Wld & Engr—Nov. 7, 1903. No. 58891.

Generating Set.

See Mechanical Engineering, Steam Engineering.

Generators.

Asynchronous Generators. A. S. McAllister. A discussion of the operation. 2200 w. Am Elect'n—Nov., 1903. No. 58881.

Gravesend.

Gravesend Borough Electricity Supply. B. Pontifex. An illustrated description of alterations and additions to an English plant. Low-tension continuous current is supplied on the three-wire system. 1600 w. Elec Engr, Lond—Nov. 6, 1903. No. 58997 A.

Hydro-Electric.

Central Power Station with Electric Distribution in Regions of Small Water Powers. F. A. C. Perrine. Abstract of a paper presented before the New England Cotton Mfrs.' Assn. On the wasteful and expensive development of power in New England, due to force of precedent and custom. Advocating transmission of power from a central plant. 1600 w. Eng News—Nov. 5, 1903. No. 58867.

The Chateaugay Water Power in the North Country. Illustrated description of a plant recently put in operation in northern New York. 500 w. Elec Wld & Engr—Nov. 21, 1903. No. 59219.

The Lachine Rapids Power House of the Lachine Rapids Hydraulic and Land Company, Limited, Montreal. R. S. Kelsch. The original and the present arrangement of generators, exciters, and switchboards, etc., are illustrated and described. 3300 w. Elec Rev, N Y—Nov. 21, 1903. No. 59207.

The Water Powers of British Columbia. E. Jacobs. A fully illustrated description of the hydro-electric stations supplying the mines, concentrating plants and cities of British Columbia. 3500 w. Engineering Magazine—Dec., 1903. No. 59162 B.

Isolated Plants.

The Systematized Operation of Isolated Plants. Percival Robert Moses. With forms and records for the organization and systematic operation of a moderate-sized electric station. 2500 w. Engineering Magazine—Dec., 1903. No. 59168 B.

Parallel Running.

Notes on the Theory of Parallel Running of Synchronous Machinery. H. C. Leake. A critical review of a paper entitled "The Parallel Working of Alternators," by Mr. B. Hopkinson. 3000 w. Elec Rev, Lond—Nov. 13 1903. No. 59087 A.

The Action of Dampers in the Parallel Running of Alternators (Die Wirkung des Dämpfers bei Parallel Arbeitenden Wechselstrommaschinen). E. Rosenberg. A discussion of the connection between damping and the reaction relation of the machines, showing that heavy flywheels obviate the necessity for damping. 7500 w. Elektrotech Zeitschr—Oct. 15, 1903. No. 59136 B.

Ryde.

The Ryde Electricity Works. Illustrates and describes the features of interest in this recently completed plant on the Isle of Wight, which circumstances limited to the least expensive type. 2500 w. Elect'n, Lond—Oct. 23, 1903. No. 58729 A.

Storage Batteries.

The Central Station Battery. R. W. Vicarey. Remarks on the care of batteries with suggestions. 1200 w. Elec Rev, Lond—Oct. 23, 1903. No. 58725 A.

The Comparative Behavior of Floating and Booster Controlled Batteries on Fluctuating Loads. Lamar Lyndon. Considers the five methods of installing a storage battery to maintain the load on the generator reasonably constant. 7000 w. Trans Am Inst of Elec Engrs—Nov. 20, 1903. No. 59301 D.

Switchboards.

The Care of Switchboards. Edwin W. Creed. An illustrated article calling at-

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tention to the care required. 2800 w. Power—Nov., 1903. No. 58832 C.

Westchester, N. Y.

Modernized District Central Station. Illustrated description of the power plant of the Bronx Gas & Electric Co., at Westchester, N. Y. 2200 w. Am Elect'n—Nov., 1903. No. 58880.

Willesden.

Recent Developments of the Metropolitan Electric Supply Co.'s Installations. Illustrated description of the progress made at Willesden, and in the sub-stations. 3000 w. Elec Rev, Lond—Nov. 13, 1903. Serial. 1st part. No. 59086 A.

LIGHTING.

Electricity v. Gas.

Some Points that Deter the Spread of Electric Lighting. F. H. Davies. Remarks on the slow progress of electric lighting in Great Britain, in competition with the use of gas, calling attention to some things that customers find annoying. 2500 w. Elec Engr, Lond—Nov. 13, 1903. No. 59091 A.

Europe.

Some Notes on the Commercial Features of European Lighting Practice. Abstract of a paper by Arthur Williams, read at the convention of the Assn. of Edison Ill. Co.'s. 2700 w. Elec Rev, N Y—Nov. 7, 1903. No. 58860.

Incandescent Lamps.

How Incandescent Lamps Are Made. E. Leavenworth Elliott. An outline of the processes and operations involved in the construction. 2500 w. Cent Sta—Nov., 1903. Serial. 1st part. No. 58914.

The Uses of Incandescent Lamps. Geo. T. Hanchett. Some of the principles by which great economies may be effected. 1800 w. Cent Sta—Nov., 1903. No. 58915.

MEASUREMENT.

Armature Inductance.

Calculation of the Apparent Inductance of Armature Coils. C. C. Hawkins. A résumé of the general principles of the calculation, supplement by a consideration of the effect of different windings. 2200 w. Elec Wld & Engr—Nov. 14, 1903. Serial. 1st part. No. 58970.

Electrometer.

An Unusual Form of Capillary Electrometer. Emilo Guarini. Illustrated description of an apparatus devised by S. W. T. Smith, of London. 600 w. Sci Am Sup—Nov. 14, 1903. No. 58987.

Frequency.

Measurement of the Frequency of Very Rapidly Alternating Currents. J. Wertheim Salomonson. An account of experimental investigations. 2000 w. Elect'n, Lond—Nov. 13, 1903. No. 59092 A.

Magnetic Units.

Magnetic Units and Other Subjects that Might Occupy Attention at the Next International Electrical Congress. A. E. Kennelly. Considers the C. G. S. system and the adapting it to practical requirements. Also discussion. 2500 w. Trans Am Inst of Elec Engrs—Oct., 1903. No. 59286 D.

Testing Alternators.

An Improved Method of Testing Large Alternators Under Full Load Conditions. B. A. Behrend. Also editorial. The magnetic balance is preserved by using different exciting currents for the motor section and for the generator section of the revolving field. 2000 w. Elec Wld & Engr—Oct. 31, 1903. No. 58770.

Units.

Theory of Units. Antonio Llano. Derives an easy and practical method for effecting the transformation from one system of units to another. Mathematical. 2500 w. Stevens Ind—Oct., 1903. No. 59296 D.

Wattmeters.

The Choice of Wattmeters. Paul MacGahan. On the importance of an accurate knowledge of the properties of a registering watt-hour meter. 1500 w. Elec Wld & Engr—Nov. 21, 1903. No. 59221.

Waves.

The Wave Measurer and Its Application (Der Wellenmesser und Seine Anwendung). J. Donitz. The instrument acts by the self-induction of a closed circuit in connection with a capacity and a hot wire indicator. 4000 w. Elektrotech Zeitschr—Nov. 5, 1903. No. 59146 B.

POWER APPLICATIONS.

Canal Haulage.

Electrical Equipment of the Miami Erie Canal. Charles W. Ricker. Illustrates and describes the equipment and plan of operation. Tows of eight or ten boats are to be hauled by a locomotive running on a track, using three-phase motors, and taking current from trolley wires at high voltage. Also editorial. 9500 w. St Ry Jour—Nov. 7, 1903. No. 58852 C.

Electric Towing on the Erie Canal. Brief illustrated description of a direct current aerial monorail system on trial at Schenectady. 1600 w. Elec Wld & Engr—Nov. 14, 1903. No. 58968.

Electric Traction on Canals. Reviews the various systems that have been tried, giving information in regard to the recent

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trials of the Wood system at Schenectady, and the system in operation on the Miami and Erie Canal. Ill. 2000 w. Eng Rec—Nov. 14, 1903. No. 58961.

Electric Driving.

Electricity in Manufacturing Plants. Walter M. McFarland. Considers briefly the older methods of power transmission and their disadvantages, contrasting them with the advantages of electric driving. Ills. 5500 w. Trans Am Soc Nav Archts & Marine Engrs, No. 10—Nov., 1903. No. 59046 D.

Requirements of Machine Tool Operation with Special Reference to the Motor Drive. Charles Day. Extracts from a paper presented before the N. Y. Elec. Soc. Discusses shop conditions, fixed charges, etc., in shops doing a general class of work. Ill. 4000 w. Ry & Engng Rev—Nov. 21, 1903. No. 59237.

Glass.

Electricity in Glass Manufacture. An illustrated detailed account of experimental works, describing the furnaces that have been patented. 2000 w. Engr, Lond—Oct. 23, 1903. No. 58736 A.

The Use of Electricity for Glass Manufacture. John B. C. Kershaw. Gives the details of construction of electric glass furnaces, with all the information available relating to the two experimental works in operation. Ill. 2200 w. Elec Rev, N Y—Nov. 21, 1903. No. 59208.

Government Service.

Electricity in the United States Government Service. J. E. Price. An illustrated article giving an interesting account of the uses, especially the distribution of correct time for public clock service, the registering of earthquake shocks, and the business of the magnetic observatory. 1300 w. Elec Rev, N Y—Oct. 31, 1903. No. 58766.

Induction Motor.

The Choice of Rotor Diameter for Induction Motors (Die Wahl des Rotordurchmessers bei Induktionsmotoren). H. M. Hobart. A discussion of the formula of Behrend with application to a practical example. 1800 w. Elektrotech Zeitschr—Nov. 12, 1903. No. 59147 B.

The Heyland Induction Motor. A. S. Langedorf. An illustrated description of the motor and its theory of operation, its advantages and disadvantages. 2500 w. Jour Assn of Engng Socs—Sept., 1903. No. 59271 C.

Mining.

Electrical Mining Notes. Sydney F. Walker. Reviews the excursions of Inst. of Min. Engrs., of England, to Sherwood and Glapwell collieries, describing their electric plants. 1400 w. Elec Rev, N Y—Nov. 14, 1903. Serial. 1st part. No. 58950.

Some Electric Mining Appliances. Illustrations with brief descriptions of hauling engines, pumps, etc., designed and constructed by the Union Elektricitäts Gesellschaft. 1500 w. Engr, Lond—Nov. 13, 1903. No. 59080 A.

Pumping Plant.

Electric Pumping Plant for De Beers Consolidated Mines, Kimberley. Illustrated description. 900 w. Elec Rev, Lond—Nov. 13, 1903. No. 59085 A.

See Civil Engineering, Water Supply.

Repulsion Motor.

The Circle Diagram of the Repulsion Motor (Das Kreisdiagramm des Repulsions-motors). M. Osnos. A discussion of the application of the vector analysis to the solution of problems of speed and torque in repulsion motors; graphical and analytical treatments are given. 4000 w. Elektrotech Zeitschr—Oct. 29, 1903. No. 59143 B.

Series Motor.

The Theory of the Compensated Series Motor (Theorie des Kompensierten Serienmotors). M. Osnos. An application of the vector analysis to the solution of problems relating to the compensated motor; graphical and analytical examples are given. 3000 w. Elektrotech Zeitschr—Nov. 12, 1903. No. 59148 B.

Single Phase.

Single-Phase Motors without Difference of Phase (Einphasenmotoren ohne Phasenverschiebung). Marius Latour. Describing the simple form of single-phase repulsion motor designed by the writer, with a mathematical discussion showing the torque at different speeds. 2000 w. Elektrotech Zeitschr—Oct. 22, 1903. No. 59138 B.

Three-Phase.

The Speed Regulation of Three-Phase Motors. Abstract translation of an article by W. Burkard in *Elektrotechnische Zeitschrift*. An illustrated explanation of the principal methods. 900 w. Elec Engr, Lond—Nov. 13, 1903. No. 59088 A.

TRANSMISSION.

Cables.

Losses in High Pressure Cables (Arbeitsverluste in Hochspannungskabeln). Dr. R. Apt and C. Mauritius. Data and results of tests of dielectric losses in transmission cables operated at pressures of 20,000 to 30,000 volts. 5000 w. Elektrotech Zeitschr—Oct. 22, 1903. No. 59139 B.

Fuses.

Fuses and Circuit Breakers in Transmission Lines. Alton D. Adams. Explains the primary object, and the quali-

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ties of each, discussing the variation in practice. 1800 w. St Ry Rev—Nov. 20, 1903. No. 59244 C.

Switches.

Oil-Break Switches and Fuses. Discusses the advantages of oil-break switches for alternating currents of high potentials, their design, etc., and gives a summary of the best developments of switchboard design. 4500 w. Elec Engr, Lond—Oct. 30, 1903. No. 58793 A.

Transmission Lines.

The Graphical Computation of Power Transmission Lines with Converters (Graphische Berechnung von Kraftübertragungslinien mit Umformern). A. Hruschka. Developing graphical diagrams for computing the various elements of a power transmission line operated by a main station in connection with converter stations. Two articles. 3500 w. Zeit für Elektrotechnik—Oct. 11, 1903. No. 59154. Each D.

MISCELLANY.

Cells.

A Method of Milking Faulty Cells. W. Dalton. Briefly describes method, giving diagram showing the connections. 500 w. Elec Engr, Lond—Oct. 23, 1903. No. 58723 A.

Electrical Problems.

The Problems That Are Facing the Electrical Engineer of To-Day and the Qualities of Mind and Character Which Are Needed to Meet Them. J. G. White. A discussion of this subject. 4500 w. Trans Am Inst of Elec Engrs—Oct., 1903. No. 59289 D.

Germany.

German Electrical Industries. Editorial review of the wonderful rise and collapse of these industries in Germany, the cause and the outlook. 3300 w. Engng—Oct. 23, 1903. No. 58735 A.

Spain.

Electrotechnics in Spain (Die Elektrotechnik in Spanien). D. Blumenthal. A general account of the development of electrical industries in Spain, and the present opening there for a market in electrical appliances. 3000 w. Elektrotech Zeitschr—Nov. 5, 1903. No. 59144 B.

Statistics.

Some Statistics Relating to Electrical Engineering. William Pollard Digby. Gives figures showing the import and export trade of the United Kingdom in electrical goods, and compares with the internal trade. 1400 w. Elect'n, Lond—Nov. 6, 1903. Serial. 1st part. No. 58995 A.

GAS WORKS ENGINEERING

Air Gas.

Air Gas. Describes methods of preparing carburetted air, its properties, defects, etc. 2800 w. Engr, Lond—Nov. 6, 1903. No. 59008 A.

Barracks.

Directions for the Lighting of French Barracks. Abstract translation of the portion relating to gas lighting, as given in a document of the Department of the French Military Administration. 2800 w. Jour Gas Lgt—Nov. 3, 1903. No. 58910 A.

Bunsen Burners.

Professor Smithells on the Bunsen Burner. Sketch of an interesting lecture, recording the results of important experimental work. 3500 w. Jour Gas Lgt—Nov. 3, 1903. No. 58909 A.

Enrichment.

The Low Candle-Power Policy and Its Critic. Editorial review of a paper on "The Policy of Gas Enrichment," by A. G. Glasgow, read before the Am. Gas Lgt. Assn. 1500 w. Gas Wld—Oct. 31, 1903. No. 58792 A.

The Policy of Gas Enrichment (Illustrated by London Practice.) Arthur Graham Glasgow. Read at the Detroit meeting of the Am. Gas Lgt. Assn. A discussion of the advantages of gas enrichment, explaining methods, especially the enrichment by carburetted water gas. 9000 w. Am Gas Lgt Jour—Nov. 9, 1903. No. 58814.

Gaseous Fuel.

A Consideration of the Gaseous Fuel Problem. Henry G. Morris. Reviews briefly the history of the use of gas as an illuminant and for fuel. Discussion. 4500 w. Pro Engrs' Club of Phila—Oct., 1903. No. 58703 D.

Gas Referees.

The Arraignment of Gas Refereeism. C. E. Jones. Discussion of some aspects of refereeism as applied to gas affairs in England. 4000 w. Jour Gas Lgt—Oct. 27, 1903. No. 58790 A.

High Pressures.

Gas Distribution at High Pressures. Reviews the paper by John A. Britton,

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read before the Pacific Coast Gas Assn. with critical remarks. 2000 w. Jour Gas Lgt—Oct. 27, 1903. No. 58789 A.

Improvements.

Enlargements and Improvements at the Stafford Corporation Gas Works. An illustrated account of changes during the last few years. 3800 w. Jour Gas Lgt—Nov. 3, 1903. No. 58908 A.

Leakage.

An Apparatus for Measuring Gas Leakage. Emil Guarini. Illustrated description of a portable gasometer used in Paris, and the method. 1000 w. Eng News—Nov. 26, 1903. No. 59258.

Mond Process.

Power Gas. Harold Medway Martin. Points out the differences between producer gas and ordinary coal gas, describes the Mond process and the uses to which it has been applied, giving illustrated descriptions of five plants in England. 6500 w. Trac & Trans—Nov., 1903. No. 58897 E.

Municipal Ownership.

Some Features of Municipal Ownership. Henry L. Doherty. Read before the Am. Gas Lgt. Assn. A consideration of questions in regard to municipal ownership, discussing the reasons offered to justify it. 8400 w. Am Gas Lgt Jour—Nov. 2, 1903. No. 58744.

Natural Gas.

Natural Gas in Steam Production. W. R. Crane. Illustrates and describes methods employed in the Kansas gas fields with a comparison of the fuel value of gas with that of coal. 3500 w. Mines & Min—Nov., 1903. No. 58739 C.

Producers.

Anthracite Gas Producers for Power Purposes. Reviews the development in this field, illustrating and describing a number of producers. 3500 w. Ir & Coal Trds Rev—Oct. 30, 1903. Serial. 1st part. No. 59072 A.

Purifying.

Simplified Method for Purifying Gas with a View to Complete Recovery of Tar and Ammonia. Summary of a paper read before the German Gas Assn. Describes a method of saturating the gas with steam. Ill. 600 w. Gas Wld—Oct. 24, 1903. No. 58715 A.

Retorts.

Notes on the Construction of Inclined Retort Settings. Archd. S. B. Little. On the designing of inclined retort settings, and present practice. Ill. 3300 w. Jour Gas Lgt—Oct. 20, 1903. Serial. 1st part. No. 58711 A.

Transmission.

Gas-Pipe v. Copper. C. Alfred Smith. Outlines a scheme for the generation and transmission of power gas, comparing costs, and discussing details. 2000 w. Elec Rev, Lond—Oct. 30, 1903. No. 58794 A.

Troubles.

Other Troubles Than Naphthalene: An Invitation for Discussion. John Terrace. Read before the So. District Assn. of Gas Engrs. & Mgrs. Considers the thick tar trouble, tar in the oxide, and other troubles. Discussion. 6000 w. Gas Wld—Nov. 14, 1903. No. 59094 A.

Water Gas.

Economic Advantages of Working a Carburetted Water-Gas Plant in Conjunction with Coal-Gas Plant. S. Carpenter. Read before the So. Dist. Assn. of Gas Engrs. & Mgrs. Considers the convenience, cost, coke factor, advantages, etc. Discussion. 8200 w. Gas Wld—Nov. 14, 1903. No. 59093 A.

Notes on the Operation of Large Carburetted Water Gas Sets. W. Cullen Morris. Read before the Am. Gas Lgt. Assn. Reviews the work of other investigators and gives data accumulated with the idea of determining the proper rate of flow of steam supply to the generators for producing the best working results, and the economy of new sets introduced. 3000 w. Am Gas Lgt Jour—Nov. 2, 1903. No. 58745.

Welsbach.

Candle-Power Tests of Welsbach Burners. Abstract of the fourth progress report of the N. E. L. A. Committee for Investigating the Photometric Value of Arc Lamps, which deals with tests of mantle gas burners and of the naked gas flame. 800 w. Elec Wld & Engr—Oct. 31, 1903. No. 58771.

INDUSTRIAL ECONOMY

Apprentices.

Apprenticeship. Robert Patterson. A paper read before the Canadian Railway Club, describing the excellent system of training apprentices in use at the shops of the Grand Trunk Railway. 2500 w. R R Gaz—Oct. 2, 1903. No. 58769.

The Training of Apprentices in Engineering Works. C. E. Downton. A description of the system and methods of

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training apprentices in the works of the Westinghouse Electric and Manufacturing Co. 3500 w. Engineering Magazine—Dec., 1903. No. 59165 B.

Coal Production.

See Mining and Metallurgy, Coal and Coke.

Day Labor.

Municipal vs. Contract Construction. James M. Head. Claims advantages of "day labor systems" over contract work, illustrating by results. 3800 w. Munic Jour & Engr—Nov., 1903. Serial. 1st part. No. 58879 C.

Economy.

Experience, Theory and Practice. Robert H. Smith. Discusses the proper standards of economical outlay. 4200 w. Engr, Lond—Oct. 30, 1903. No. 58804 A.

Education.

Industrial Education in Europe. Reviews progress made in Italy, Holland, Russia, Sweden, Norway, Switzerland, Austria, and France. 3000 w. U S Cons Repts—Nov., 1903. No. 58811 D.

Mining Instruction in Germany. Particulars relating to the courses in mining at various educational institutions in Germany, extracted from report by Dr. Frederick Rose. 2500 w. Col Guard—Oct. 30, 1903. No. 58796 A.

The Proper Qualifications of Electrical Engineering School Graduates from the Telephone Engineer's Standpoint. Bancroft Gherardi, Jr. Discusses education with reference to the providing the necessary qualifications needed in this work. 3500 w. Trans Am Inst of Elec Engrs—Oct, 1903. No. 59290 D.

The Typical College Courses Dealing with the Professional and Theoretical phase of Electrical Engineering. Dugald C. Jackson. Shows the wide variance between the methods of the colleges and discusses the essentials preparatory to professional studies, the courses, etc. 4000 w. Trans Am Inst of Elec Engrs—Oct, 1903. No. 59291 D.

Labor.

An Opportunity for the Building Trade Unions. Editorial discussion of existing conditions in the building trade with suggestions for a remedy. 1800 w. Ir Age—Nov. 26, 1903. No. 59251.

Is Organized Labor Right? The Only Question. David M. Parry. Discusses the "closed shop," wages, &c. Also considers attitude of employers' associations. 2500 w. Bankers' Mag, N Y—Nov., 1903. No. 58944 D.

The Labor Problem. From the annual address of Pres. I. E. Knisely before the Ohio Bankers' Assn. The relations of labor and capital are briefly discussed. 01000 w. Bankers' Mag, N Y—Nov., 1903. No. 58945 D.

Mosely Commission.

Mr. Mosely's Industrial Inquiry. Translated from a paper published by the Union of Metal and Mine Workers of France. Discussion of the first commission's visit to the United States. 4500 w. U S Cons Repts—Nov., 1903. No. 58810 D.

Oil.

The Oil Industry of California from a Commercial Standpoint. Dr. Deane. Information concerning the oil deposits, methods of well sinking, production, consumption, &c. 8000 w. Jour of Elec—Nov., 1903. No. 58926 C.

Strike.

Chicago Street Railway Strike. An account of the methods of obstructing tracks adopted by the union and its sympathizers, and of the troubles and attitude of those in authority. Ill. 1800 w. St Ry Jour—Nov. 21, 1903. No. 59212 C.

Works Management.

Manufacturing: Capital, Costs, Profits and Dividends. Henry Hess. Developing an improved graphical method of analyzing and interpreting cost accounts and works records. An important paper. 3500 w. Engineering Magazine—Dec., 1903. No. 59164 B.

MARINE AND NAVAL ENGINEERING

Address.

Presidential Address before the Institution of Civil Engineers. Abstract of the address of Sir William Henry White, on naval and mercantile marine matters in Great Britain. A review of progress during forty-four years. 5000 w. Engng—Nov. 6, 1903. Serial. 1st part. No. 59006 A.

Boilers.

German Marine Boiler Construction. Frank C. Perkins. Illustrations, with description of the making of the Dürr water-tube marine boilers. 1700 w. Sci Am Sup—Nov. 14, 1903. No. 58984.

Cable Steamer.

The Twin-Screw Cable Steamer "Stephan" (Der Doppelschrauben-Kabeldampfer "Stephan"). H. Hildebrandt. Illustrated description of the new steamer constructed for use in laying the second

We supply copies of these articles. See page 637.

German trans-Atlantic cable. 3000 w. 2 plates. Zeitschr d Ver Deutscher Ing—Oct. 31, 1903. No. 59104 D.

Evaporators.

Evaporators and Distillers. W. W. Edwards. Modern means of securing fresh water at sea. Various types are illustrated and described. 5300 w. Marine Engng—Nov., 1903. No. 58828 C.

Ferry-Boats.

Progressive Trials of Ferry-Boat Bremen. Col. Edwin A. Stevens. Gives results of the analysis of the trials. 1400 w. Trans Am Soc Nav Archts & Marine Engrs, No. 1.—Nov., 1903. No. 59038 D.

The Steam Ferry over the North Sea Canal at Velzen (De Stoomponten voor het veer over het Noordzee kanaal te Velzen). C. Kloos. Illustrating a chain tow ferry system across the North Sea Canal in Holland. 1000 w. De Ingenieur—Oct. 24, 1903. No. 59152 D.

Gasoline Engines.

Gasoline Engines for Marine Propulsion. D. H. Cox. Presents facts showing progress and development of these engines, drawing conclusions therefrom. Ills. 6000 w. Trans Am Soc Nav Archts & Marine Engrs, No 4—Nov., 1903. No. 59040 D.

Petroleum Motors on Fishing Boats (Les Moteurs à Pétrole à Bord des Voiliers de Pêche). C. Birault. Describing the installation of small internal-combustion motors as auxiliaries on sailing vessels. 2500 w. Génie Civil—Oct. 31, 1903. No. 59113 D.

German Navy.

The Imperial German Navy. Archibald S. Hurd. Reviews the recent naval expansion, giving illustrations. 3000 w. Cassier's Mag—Nov., 1903. No. 58892 B.

German Steamer.

The German Lake Steamer Stadt Meersburg. Translated from *Zeitschrift des Vereins Deutscher Ingenieure.* Illustrated description of a paddle wheel steamer recently placed on Lake Constance to connect the railways of the German shore with the Swiss cities on the lake. 2000 w. Naut Gaz—Nov. 5, 1903. No. 58816.

Launch.

Coaching Steam Launch Moguntia with Petroleum Fuel. Translated from *Zeitschrift des Mitteleuropäischen Motorwagen Verein.* An illustrated account of a high-speed pleasure launch. 1400 w. Marine Engng—Nov., 1903. No. 58829 C.

Launching.

Launching of Large Merchant Vessels. William A. Fairburn. Considers the statistics and dynamics of stern launching, giving data of merchant vessels. 6500 w. Trans Am Soc Nav Archts & Marine Engrs, No. 16—Nov., 1903. No. 59052 D.

Notes on Launching of the Cruiser Chattanooga. Mason S. Chace. An account of the method employed to check and stop the ship before she had moved more than 283 ft. Ill. 2500 w. Trans Am Soc Nav Archts & Marine Engrs, No. 14—Nov., 1903. No. 59050 D.

Notes on Side Launchings. William G. Groesbeck. Describes the side launching of the cruiser Galveston and the suction dredge Benyuard. 1500 w. Trans Am Soc Nav Archts & Marine Engrs, No. 15—Nov., 1903. No. 59051 D.

Metric System.

The Metric System in Relation to the Shipbuilding Industry of the United States. J. H. Linnard. Considers the effect of introducing the metric system in its application to the shipbuilding and marine engine industry, not favorable to its adoption. 4700 w. Trans Am Soc Nav Archts & Marine Engrs, No. 9—Nov., 1903. No. 59045 D.

Motor Boat.

Long Trial Trip with Fast Motor Boat. Describes a trip from Rhode Island to Michigan in a sixty-foot motor boat of 80 h. p. in two engines. 1000 w. Automobile—Oct. 31, 1903. No. 58748.

Oil-Motor Boat for the Uganda Railway Company. Illustrated description of a boat to be used on Lake Victoria. 1400 w. Engng—Nov. 6, 1903. No. 59004 A.

Ship Curves.

Curves of Form of the Initial Condition. George Crouse Cook. A simple method of calculating and recording (by curves) the data of form useful in designing vessels. 10500 w. Trans Am Soc Nav Archts & Marine Engrs, No. 8—Nov., 1903. No. 59044 E.

On Ships' Forms Derived by Formulae. D. W. Taylor. Derives formulae for waterlines, sections, &c., explaining their value in the designing of vessels. Tables, diagrams, &c. 6000 w. Trans Am Soc Nav Archts & Marine Engrs, No. 12—Nov., 1903. No. 59048 D.

Stability.

A Graphic Method for the Calculation of the Stability of Ships. M. H. Bauer. Explains this method in detail. 3500 w. Trans Am Soc Nav Archts & Marine Engrs— Nov. 18, 1903. No. 59054 D.

Displacement and Stability Calculations by Improved Methods. Prof. W. S. Leland. Explains forms arranged for classroom use, in the hope they may be of practical use. 2000 w. Trans Am Soc Nav Archts & Marine Engrs, No. 17—Nov., 1903. No. 59053 D.

Steamships.

Description of the Design and Building of the 21,000-Ton Steamships Minnesota

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and Dakota. Charles R. Hanscom. Describes the yard and equipment and the difficult problems encountered. Fully illustrated. 13600 w. Trans Am Soc Nav Archts & Marine Engrs, No. 11—Nov, 1903. No. 59047 F.

Mallory Line Twin Screw Passenger and Freight Steamship San Jacinto. Illustrated detailed description of a new vessel for service between New York and Galveston, Tex. 5400 w. Marine Engng—Nov., 1903. No. 58825 C.

The Boston Steamer Old Colony. An illustrated description of a new excursion boat for service in Boston harbor. 1200 w. Naut Gaz—Nov. 19, 1903. No. 59234.

The Steamship Yongala. Illustrates and describes a vessel designed for the Australian coasting and passenger trade. 900 w. Eng, Lond—Oct. 30, 1903. No. 58807 A.

Submarine.

The Success of the Submarine. Archibald S. Hurd. Discusses the British and French submarines, and their value as instruments of warfare. 4500 w. Nineteenth Cent—Nov., 1903. No. 59033 D.

Torpedo Vessels.

Some Notes on the Performance of the Torpedo Vessels of the United States Navy at Sea. Lieut. L. H. Chandler. Tables of information with explanatory notes. 2000 w. Trans Am Soc Nav Archts & Marine Engrs, No. 13—Nov., 1903. No. 59049 D.

Warships.

Water-Tight Subdivision of Warships. Com. William Hoogaard. A study of the principles which underlie the application of water-tight subdivision in warships. 11700 w. Trans Am Soc Nav Archts & Marine Engrs., No. 6—Nov., 1903. No. 59042 E.

Water-Tightness.

Methods of Securing Water-Tightness of plates at Conduit and Tubes. George McQuilkin, Jr. Illustrates and describes types in use, especially in the care of water-tight bulkheads, and recommends standardization. 3300 w. Marine Engng—Nov., 1903. No. 58826 C.

Yachts.

Some Thoughts on the Design of Modern Steam Yachts. Clinton H. Crane. Gives plans of the steam yacht Noma, built by the Burlee Dry Dock Co., of Staten Is., as an example of modern design. Ills. 1000 w. Trans Am Soc Nav Archts & Marine Engrs, No. 5—Nov., 1903. No. 59041 D.

MECHANICAL ENGINEERING

AUTOMOBILES.

Accumulators.

Electric Automobile Accumulator Cells for Quick Charge Rates. E. Kilburn Scott. Remarks on the Elieson plate cell, and a solidly-built cell designed by Mr. Niblett, in which the buckling trouble is done away with. 1400 w. Elec Engr, Lond—Nov. 13, 1903. No. 59089 A.

Electric Carriages.

Electric Automobiles. H. F. Joel. Abstract of a paper read before the Inst of Civ. Engrs., England. Reviews this industry, and the progress made, giving information of interest. 2000 w. Sci Am Sup—Nov. 7, 1903. No. 58887.

Hill Climb.

Gaillon Hill Climb. An illustrated description of this recent test. 1200 w. Auto Jour—Nov. 14, 1903. No. 59097 A.

Internal Combustion.

Governing Gas and Petrol Engines. Dugald Clerk. Excerpts from a paper read at meeting of the Automobile Club, London. Briefly considers methods that have been and are in use. 1500 w. Auto Jour—Oct. 31, 1903. No. 58788 A.

Knox Car.

Description of the Two-Cylinder Knox Car. Herbert L. Towle. Detailed account with illustrations. 3800 w. Automobile—Nov. 7, 1903. No. 58815.

Korte Car.

The 14 H. P. Two-Cylinder Korte Car. Drawings and description. 2000 w. Autocar—Oct. 24, 1903. No. 58714 A.

Light Car.

The 5 H. P. Vauxhall Light Car. Illustrated description of a light car propelled by mechanism of the simplest character, and easily controlled. 1800 w. Autocar—Oct. 31, 1903. No. 58787 A.

Motors.

Evolution of Light High-Speed Motors. Herbert L. Towle. An explanation of the principles of design entering into the manufacture of motors intended for automobiles of high first cost. 3000 w. Automobile—Nov. 21, 1903. Serial. 1st part. No. 59238.

Napier.

The 1904 Napier Model. Brief description of some of the novel features. Ill.

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1200 w. Auto Jour—Oct. 24, 1903. No. 58713 A.

Omnibuses.

Motor Omnibuses in Great Britain. Martha L. Root. Illustrates the vehicles being put in service in London, and gives information of other systems. 1700 w. Automobile—Nov. 14, 1903. No. 58935.

Petrol Cars.

The Dennis Petrol Motor Cars. Begins an illustrated detailed description of these cars. 700 w. Prac Engr—Oct. 23, 1903. Serial. 1st part. No. 58716 A.

Racing.

Skidding on the Race Track Analyzed. Showing the importance of the driver's position. 1100 w. Automobile—Nov. 14, 1903. No. 58937.

Steam Cars.

The Cremorne Steam Cars and Automobile Parts. Begins an illustrated detailed description. 1800 w. Auto Jour—Nov. 14, 1903. Serial. 1st part. No. 59096 A.

Steam Van.

Waring's "Gillett" Motor Van. Illustrates and describes a steam delivery van. 2000 w. Auto Jour—Nov. 7, 1903. No. 58991 A.

Tires.

A New Motor Tyre. An illustrated description of the new Palmer tyre. 2000 w. Autocar—Nov. 14, 1903. No. 59098 A.

A Study of the Failure of Automobile Tires (Etude du Dérapage des Automobiles). J. Résal. An examination of the forces acting upon an automobile, with especial reference to the stresses tending to strip the pneumatic tires from the wheels. Two articles. 4000 w. Génie Civil—Oct 17, 24, 1903. No. 59109 each D.

Traction Experiments.

The Resistance of Road Vehicles to Traction. Abstract of a report of a committee of the British Assn. 3000 w. Elect'n, Lond—Oct. 23, 1903. No. 58730 A.

Tractors.

Power-Steered Electric Tractors for Commercial Vehicles. Illustrated description of a mechanism patented in Italy and soon to be put on the market in the United States. 600 w. Automobile—Oct. 31, 1903. No. 58747.

Trials.

Industrial Car Trials in Paris. Remarks on these trials, the few vehicles entered, and lack of interest. 1600 w. Engr, Lond—Nov. 6, 1903. No. 59009 A.

Wheels.

The Wheels for Automobiles. Extract from a paper read by Commandant Ferrus at the Paris International Automobile Congress. Gives some points in regard to the manufacture of wheels. 800 w. Automobile—Nov. 14, 1903. No. 58936.

HYDRAULICS.

Air Lift.

Raising Water by Compressed Air. William H. Maxwell. Read before the British Assn. of Water-Works Engrs. Gives the working results of a plant on the "air-lift" system at Tunbridge Wells, with a general review of the conditions under which the system may be successfully applied. 3500 w. Engng—Nov. 13, 1903. No. 59078 A.

Centrifugal Pumps.

Fans and Centrifugal Pumps for High Pressures Driven by Steam Turbines or Electro-Motors. Summary of a paper by Prof. A. Rateau, in the *Bulletin de la Société de l'Industrie Minerale*. Ill. 2300 w. Prac Engr—Nov. 6, 1903. Serial. 1st part. No. 58994 A.

Theory of Centrifugal Pumps and Fans: Analysis of Their Action, with Suggestions for Designs. Continued discussion on paper by Elmo G. Harris. 7200 w. Pro Am Soc of Civ Engrs—Oct., 1903. No. 58708 E.

Electric Pumps.

See Civil Engineering, Water Supply.

See Electrical Engineering, Power Applications.

Flow.

An Experimental Study of the Resistances to the Flow of Water in Pipes. E. G. Coker and George W. Fenkell. Continued discussion of paper by Augustus W. Saph and Ernest W. Schoder. 1200 w. Pro Am Soc of Civ Engrs—Oct., 1903. No. 58707 E.

Hydraulic Engine.

Hydraulic Driven Pumping Plant (Hydraulisch Betriebene Wasserhaltungsanlage). H. Unger. A detailed description of direct-acting hydraulic engines driving drainage pump at the Altendorf Mine at Dahlhausen on the Ruhr. 2000 w. 2 plates. Glasers Annalen—Nov. 1, 1903. No. 59129 D.

Hydro-Electro Plants.

See Electrical Engineering, Generating Stations.

Niagara.

Hydraulic Features of the Plant of the Niagara Falls Power Company. The present article reviews the general considerations, describing the canal and intakes. Ill. 4000 w. Eng Rec—Nov. 21, 1903. Serial. 1st part. No. 59201.

Pumps.

A History of Pumps, Ancient and Modern. John A. Drew. A lecture delivered

before the Brooklyn's Engrs.' Club. Historical review with illustrations. 6000 w. Engr, U S A—Nov. 16, 1903. No. 59020 C.

Water Power.

The Utilization of Waterfalls (Utilisation des Chutes d'Eau). F. Loppé. A review of the work of the Congrès de la Houille Blanche, with regard to the development of the water powers of France. 2000 w. Revue Technique—Oct. 25, 1903. No. 59116 D.

MACHINE WORKS AND FOUNDRIES.

Annealing.

Annealing. E. R. Markham. Suggestions for properly heating and cooling to obtain success. 1000 w. Am Mach—Nov. 5, 1903. No. 58824.

Blast Furnaces.

See Mining and Metallurgy, Iron and Steel.

Blow Holes.

See Mining and Metallurgy, Iron and Steel.

Boring.

Aligning and Boring Large Engine Frames. Illustrates and describes the methods used by a firm in Providence, R. I. 500 w. Am Mach—Nov. 5, 1903. No. 58821.

Castings.

Pickling Castings. Some points on methods in use, the acids and the dangers accompanying their use. 1200 w. Foundry—Nov., 1903. No. 58696.

Cores.

Cores for Aluminium Castings. Walter J. May. Reports satisfactory results with cores made of asbestic coated with steatite. 700 w. Prac Engr—Oct. 30, 1903. No. 58693 A.

Cranes.

Gantry Crane of the Buffalo Dry-Dock Company. Illustrated description of a large cantilever crane for handling material. 900 w. Marine Engng—Nov., 1903. No. 58827 C.

Die-Forging.

Hammers Used in Die-Forging. Illustrates and describes types of hammers used largely in the work of die-forging. A supplementary article to a recently published series. 1600 w. Engng—Nov. 6, 1903. Serial. 1st part. No. 59003 A.

Drawing Instrument.

Tooth Curve Drawing Instrument. Franz Hass. Translated and abridged from the *Zeitschrift des Vereines Deutscher Ingenieure*. Illustrated description of the method and instrument. 1100 w. Am Mach—Nov. 19, 1903. No. 59016.

Drawings.

A Filing and Indexing System for Drawings. E. C. de Wolfe. Describes the system used by the Dodge Mfg. Co., at Mishawaka, Ind. 3000 k. Am Mach—Nov. 12, 1903. Serial. 1st part. No. 58933.

Electric Power.

See Electrical Engineering, Power Applications.

Foundry Plant.

An Interesting Study of Foundry Development. Illustrated description of a foundry in Newark, N. J., where electric motors tend to economy in the handling of raw materials and castings. 2500 w. Elec Rev, N Y—Oct. 31, 1903. No. 58767.

Foundry Plant of Maher & Flockhart at Newark, N. J. Illustrated description of works which have been gradually enlarged to meet the requirements. 2500 w. Foundry, Nov., 1903. No. 58697.

The Foundry and Town of Trafford City, Pa. An illustrated article giving information concerning this extensive plant. 3500 w. Eng Rec—Oct. 31, 1903. No. 58760.

Foundry Iron.

Blast Furnace Conditions and the Composition of Foundry Iron. W. Walley Davis. Read before the Am. Found. Assn. Discusses the important points in the manufacture of foundry iron. 3000 w. Foundry—Nov., 1903. No. 58701.

Economy in Buying, Mixing and Melting Iron. Herbert E. Field. Read at meeting of Pittsburg Found. Assn. Discusses points of importance in methods the writer considers most economical. 5500 w. Ir Trd Rev—Nov. 12, 1903. No. 58939.

Frames.

Design of Punch and Riveter Frames. John S. Myers. Describes method of making necessary calculations, illustrating by example. 2000 w. Mach, N Y—Nov., 1903. No. 58757 C.

Governors.

Treatment of Shaft Spring Governors. Hubert E. Collins. Considers the difficulties that may occur in the handling of a shaft-governor, with the remedies, giving rules for the regulation and speeding. Ill. 2300 w. Engr, U S A—Nov. 2, 1903. No. 58974 C.

Grinding.

Emery Wheel Practice in Foundries. Charles G. Smith. Read before the Pittsburg Found. Assn. Discusses foundry grinding, especially the uses for emery wheels. 2300 w. Foundry—Nov., 1903. No. 58698.

Universal and Tool Grinding Machine.

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Illustrated detailed description of a new machine. 800 w. Am Mach—Nov. 5, 1903. No. 58823.

Index Plates.

Making Accurate Index Plates. Jos. M. Stabel. Illustrates and describes methods used by the writer. 1400 w. Am Mach—Nov. 19, 1903. No. 59015.

Lathes.

Automatic Turret Lathe Development at the Works of the Potter & Johnston Machine Company. Illustrated description of the lines of development. 1500 w. Am Mach—Nov. 5, 1903. No. 58822.

Brass-Finishers Lathes. Illustrated description of lathes especially designed for repetition work. 1800 w. Engng—Nov. 13, 1903. No. 59075 A.

Lathe Work.

Rapid Reduction in the Lathe as Compared with Forgings. Frank B. Kleinhaus. Illustrated description of methods of arrangement of tools for rapid reduction work. 800 w. Eng News—Nov. 5, 1903. No. 58862.

Milling.

Large Plano-Milling and Profiling Machine. An illustrated description of a machine designed for heavy work. 800 w. Engr, Lond—Oct. 30, 1903. No. 58805 A.

Molding.

Drying Molds. Henry Hess. Remarks on methods, with description of a combination of small stove, small blower, and small electric motor to drive the blower. 1000 w. Foundry—Nov., 1903. No. 58699

The Bottom of a Green Sand Mold. Thomas D. West. Read before New England Foun. Assn. A discussion of the principles involved in making green sand castings, illustrating methods commonly practiced. 3000 w. Ir Trd Rev—Nov. 12, 1903. No. 58938.

The Top of a Green Sand Mold. Thomas D. West. Read at meeting of New England Found. Assn. Considers points of importance, and methods of securing desired results. 4000 w. Ir Trd Rev—Nov. 19, 1903. No. 59223.

New Plant.

The Ambridge Plant of the American Bridge Company. An illustrated description of the arrangement, operation, power, transportation and buildings. 5500 w Eng Rec—Nov. 21, 1903. Serial. 1st part. No. 59202.

Pipe Foundry.

Pipe Foundry of the Massillon Iron & Steel Company, Massillon, O. Illustrated detailed description of the plant and its equipment. 1200 w. Foundry—Nov., 1903. No. 58700.

Rolling Mill.

Reverse Curves Rolling Mill. Illustrated description of a machine designed for the rolling of reverse curves from the flat strip or hoop. 1000 w. Engr, Lond—Oct. 30, 1903. No. 58808 A.

Rolls.

The Calibration of Rolls (Das Kalibrieren der Walzen). Alexander Sattmann. A discussion of the method of proportioning the passes in the rolls of mills for rolling structural shapes of iron or steel, so as to effect the reduction and forming of the desired profiles. 3000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 17, 1903. No. 59130 D.

The Calibration of Rolls for Rolling Mills (Die Kalibrierung der Walzen im Walzwerksbetriebe). Emil Kirchberg. Describing the method of laying out the passes in rolls for rolling I beams and structural shapes. 3500 w. Stahl u Eisen—Oct. 15, 1903. No. 59156 D.

Screw-Threads.

Cutting Fractional Screw Threads. Fred H. Colvin. An explanation of ways of solving various problems. 1800 w. Mach, N Y—Nov., 1903. No. 58758 C.

Shears.

Electric, Steam and Hydraulic Shears at German Steel Works. Frank C. Perkins. Illustrates and describes various types. 1600 w. Mod Mach—Nov., 1903. No. 58786.

Shops.

New Shop of the Cincinnati Shaper Co. Illustrated description of a shop manufacturing crank, geared and traverse shapers. 2000 w. Mach, N Y—Nov., 1903. No. 58756 C.

The Works of Messrs. Meldrum Brothers, Ltd. An illustrated detailed description of new works and their equipment, near Manchester, Eng. 5500 w. Trac & Trans—Nov., 1903. No. 58899 E.

Works of the Marine Engine and Machine Co. Illustrates and describes these large modern shops at Harrison, N. J., and the methods and processes used in a wide range of work. 3500 w. Eng Rec—Oct. 31, 1903. No. 58762.

See Railway Engineering, Permanent Way and Buildings.

See Street and Electric Railways.

Steel Castings.

Steel Castings and the Tropenas Process. Arthur Simonson. Read at meeting of the New England Found. Assn. Considers steel and its characteristics, the manufacture of steel castings, and problems of the foundry, the sphere of the Tropenas process and the features of operation. 4000 w. Ir Trd Rev—Oct. 29, 1903. No. 58746.

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MATERIALS OF CONSTRUCTION.

Alloys.

Alloys of Aluminum. From a paper by Joseph W. Richards before the Am. Soc. of Test. Materials, on the qualities of the different alloys and their preparation. 600 w. Am Mach—Nov. 12, 1903. No. 58931.

Aluminothermics.

Alumino-thermics and Rail Welding. Dr. Hans Goldschmidt. Abstract of a lecture before Columbia Univ. Chem. Soc. Describes the process of thermic welding, giving report of tests made on the strength of thermit joints. Ill. 1800 w. St Ry Jour—Nov. 14, 1903. No. 58953 C.

Aluminothermics. Hans Goldschmidt. Chiefly considers the practical applications. Supplementary to an article by Dr. G. P. Scholl, in Jan. issue. Ill. 4500 w. Electro-Chem Ind—Nov., 1903. No. 58928 C.

The Aluminothermic Processes (Les Procédés Aluminothermiques). E. Dieudonnè. Describing the practical applications of the Goldschmidt process to the welding of rails and similar operations. 2000 w. Revue Technique—Oct. 25, 1903. No. 59117 D.

Deformations.

An Experimental Study of Permanent Deformations (Etude Experimentale des Deformations Permanentes). H. Bouasse. A fundamental treatment of the deformation of materials produced by stresses of various kinds. 7500 w. Bull Soc d' Encour—Oct. 31, 1903. No. 59126 G.

Ferro-Alloys.

On the Manufacture of Ferro-Alloys in General and of Ferro-Titanium in Particular in the Electric Furnace. Auguste J. Rossi. Treats of the electrical smelting and the reduction. 5000 w. Electro-Chem Ind—Nov., 1903. No. 58927 C.

Rust.

The Pitting Rust of Iron. Dr. W. H. Birchmore. An account of the writer's observations and experiments in making a study of this trouble. 2800 w. Am Gas Lgt Jour—Nov. 16, 1903. No. 58941.

Testing.

The Influence of Form and Production upon the Resistance of Cast Iron Test Pieces (Einfluss der Form und Herstellungsweise von Gusseisernen Probestäben auf deren Festigkeit). P. Reusch. With numerous examples showing how the apparent resistance may vary according to the shape and manner of casting. 2500 w. Stahl u Eisen—Nov. 1, 1903. No. 59157 D.

Tool Steels.

Experiments with High-Speed Tool Steels. Report on experiments with rapid-cutting steel tools made at the Manchester (Eng.) Municipal School of Technology, under the auspices of a joint committee, to test the capabilities. Also editorial. 6000 w. Mech Engr—Oct. 31, 1903. Serial. 1st part. No. 58791 A.

High-Speed Tool Steels. Review of Dr. Nicolson's report of tests made on lathe tools. 3500 w. Engr, Lond—Oct. 30, 1903. No. 58803 A.

Rapid-Cutting Tool Steels. Dr. J. T. Nicolson. Report on experiments with rapid-cutting tool steels, made under the auspices of a Joint Committee. Ill. 8000 w. Engng—Oct. 30, 1903. Serial. 1st part. No. 58798 A.

Rapid-Cutting Tool Steels. Report of the discussion on the paper read by Dr. J. T. Nicolson. 6500 w. Engng—Nov. 13, 1903. No. 59074 A.

Wire.

Hard Drawn Copper Wire. Francis W. Jones. Abstract from *Telegraph Age*. Some points on the properties of this wire, the sag and elongation. 1000 w. Elec Rev, N Y—Nov. 21, 1903. No. 59209.

MEASUREMENT.

Centrifugal Force.

Centrifugal Force and its Applications in General and Technical Mechanics (Die Zentrifugalkräfte und ihre Anwendung in der Kosmischen und Technischen Mechanik). Dr. Holzmüller. A summary of the laws governing the action of centrifugal force, considered both in relation to space in general, and in connection with the attraction of the earth. 3500 w. Zeitschr d Ver Deutscher Ing—Nov. 7, 1903. No. 59107 D.

Dynamometers.

European Designs of Dynamometers. E. P. Buffet. Illustrated descriptions derived from articles in the *Revue Industrielle*, and *Kraft*. 1500 w. Am Mach—Nov. 26, 1903. No. 59253.

Metric System.

See Marine and Naval Engineering.

Screw-Measuring.

Screw-Measuring Machine at the National Physical Laboratory. Illustrates and describes a machine for micrometrically testing the accuracy of commercially-produced screw-threads and taps. 1200 w. Engng—Nov. 13, 1903. No. 59076 A.

POWER AND TRANSMISSION.

Air Compressor.

A New Type of Air Compressor. W. H. Booth. Illustrates and describes a compact, duplex, two-stage compressor, direct-driven by an electric motor, adapted to use in mines or shops. Made by an English company. 2200 w. Mines & Min—Nov., 1903. No. 58740 C.

We supply copies of these articles. See page 637.

Four-Stage Air Compressor for 850-lbs. Pressure. Illustrated description of an interesting machine recently installed at the Aragon mine at Norway, Mich., for the purpose of supplying compressed air for locomotives for the haulage system. 1700 w. Eng News—Nov. 26, 1903. No 59255.

Ball Bearings.

Diagram for Fnding the Diameter of Ball Bearings. P. S. Bushnell. With explanatory notes. 500 w. Am Mach—Nov. 12, 1903. No. 58932.

Compressed Air.

The Use of Compressed Air for Operating the Contractor's Plant at the Wachusett Dam. An account of the use of compressed air on a large scale in contract work noting some of its advantages. Ill. 1200 w. Eng News—Nov. 26, 1903. No. 59254.

Transmission of Compressed Air for Power. L. C. Bayles. Explains the method of determining the most economical size of pipe to use for the transmission. 700 w. Compressed Air—Nov., 1903. No. 59032.

Conveying Machinery.

Recent Developments in Conveying Machinery. A. Little. Abstract of a paper read before the Birmingham Assn. of Mech. Engrs. Describes briefly installations showing the progress made. 2700 w. Prac Engr—Nov. 13, 1903. No. 59200 A.

Pneumatic Tubes.

Pneumatic Tube System of the New York Stock Exchange. Edmund A. Fordyce. Brief illustrated description of the installation, with remarks on the importance of the service. 1000 w. Compressed Air—Nov., 1903. No. 59031.

Power Generation.

The Value of Combustibles for the Generation of Power (Die Auswertung der Brennstoffe als Energieträger). C. Linde. An important paper before the *Verein Deutscher Ingenieure* discussing the transformation of heat energy into mechanical work. 5000 w. Zeitschr d Ver Deutscher Ing—Oct. 17, 1903. No. 59100 D.

Shafts.

A chart for Calculating the Strength of shafts and Pins. Gilbert S. Walker. Gives a draft intended to simplify the calculations, with explanatory notes. 2200 w. Am Mach—Nov. 26, 1903. No.59252.

SPECIAL MOTORS.

Gas Engines.

Different Gases in Gas Engines. Prof. Alfred H. White. Lecture delivered at the Detroit meeting of the Am. Gas Lgt. Assn. Considers the influence of the kind of gas used, explaining the phenomena which take place in the engine cylinder. 5500 w. Am Gas Lgt Jour—Nov. 16, 1903. No. 58940.

700-Horse-Power Double-Acting Gas-Engine; Körting System. An illustrated detailed description of the engine and its working. 1600 w. Engng—Oct. 30, 1903. No. 58799 A.

1,600 Horse-Power Gas Engine and Three-Phase Alternator at Laar Power Plant, and Other High-Power Blast Furnace Gas Engines. Frank C. Perkins. Illustrations with brief descriptions. 900 w. Elec Rev, N Y—Nov. 7, 1903. No. 58859.

Gasoline Engines.

See Marine and Naval Engineering.

Gas Power.

Experiments on a Suction Gas Plant (Untersuchungen an einer Sauggasanlage). Kurl Bräuer. Data and results of tests. The suction stroke of the gas engine produces the down draft in the producer. A fuel consumption of 0.32 kilogram of coal per 1 H. P. was attained. 4000 w. Zeitschr d Ver Deutscher Ing—Oct. 17, 1903. No. 59101 D.

The Economical Use of Engines Fed with Lean Gas (Emploi Economique des Moteurs à Gas Pauvre). F. Gramyr. A description of the gas producer engines, and machinery installed at the potteries at Embrach. 4000 w. Revue Technique—Nov. 10, 1903. No. 59118 D.

Internal Combustion.

See Mechanical Engineering, Automobiles.

STEAM ENGINEERING.

Boilers.

Circulation in Water-Tube Boilers. Suggests a cause which it is believed will not only account for circulation, but for erratic performances which frequently cause disaster. 2800 w. Engr, Lond—Nov. 6, 1903. No. 59012 A.

Water-Tube Boilers. William Fyvie. States the factors in favor of water-tubes for land purposes, discussing each, and also considering the weaknesses. 2400 w. Aust Min Stand—Oct. 1, 1903. Serial. 1st part. No. 58906 B.

See Marine and Naval Engineering.

See Railway Engineering, Motive Power.

Boiler Setting.

Boiler Settings. Charles L. Hubbard. An illustrated article considering the important requirements. 1800 w. Am Elect'n —Nov., 1903. No. 58885.

Boiler Tubes.

Non-Corrosive Nickel Steel Boiler Tubes. Albert Ladd Colby. Information concerning nickel-steel tubes as made in Europe and America, cost, properties, ap-

plications, etc. Ill. 5000 w. Trans Am Soc Nav Archts & Marine Engrs, No. 7—Nov., 1903. No. 59043 D.

Condenser.

The Central Condenser Plant at the Maria Mine at Pribram (Die Zentral Kondensationsanlage System Balcke am Mariaschachte in Pribram). Julius Divis. Describing a condenser plant receiving the exhaust of all the engines of the mine; Balcke cooling towers are used, and 43,000 kilograms of steam condensed in 24 hours. 3000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 31,1903. No. 59132 D.

Connecting Rods.

The Acceleration Stresses on Connecting Rods (Der Beschleunigungsdruck der Schubstange). Dr. R. Mollier. An analytical and graphical examination of the stresses produced in connecting rods by the acceleration changes at various parts of the stroke. 1800 w. Zeitschr d Ver Deutscher Ing—Nov. 7, 1903. No. 59108 D.

Locomotive Connecting and Side Rods. George Willans. An illustrated investigation of the designs of modern rods, comparing them with earlier practice. 2200 w. Prac Engr—Nov. 13, 1903. Serial. 1st part. No. 59099 A.

Crank Pins.

Keying Up Crank Pins. William Kavanagh. Describes various methods, and considers the causes of heating. 1200 w. Power—Nov., 1903. No. 58833.

Engines.

Adjusting Clearance and Setting the Valves of Corliss Steam Engines. John L. Plock. Describes method, giving illustration. 1500 w. Power—Nov., 1903. No. 58830 C.

A New Type of Steam Engine (Nouveau Type de Machine à Vapeur). A discussion of an ideal type of steam engine suggested by M. Friedenthal in which a combustible vapor should be used first to develop its expansive force and then burned. 2000 w. Revue Technique—Nov. 10, 1903. No. 59119 D.

Heat Economy of the Steam Engine. Translated from Prof. Lynen's "Die Wärmeausnutzung bei der Dampfmaschine." Ill. 5600 w. Stevens Inst—Oct., 1903. No. 59295 D.

The Franco Tosi Engines. A. H. Allen. Illustrated detailed description of types made in Italy. 1300 w. Engr, U S A—Nov. 2, 1903. No. 58972 C.

Evaporators.

See Marine and Naval Engineering.

Flywheels.

Flywheels and Flywheel Accidents. R. T. Strohm. Considers the stresses set up when a flywheel revolves at a constant velocity, the causes of flywheel destruction and the prevention of disasters. 3300 w. Am Elect'n—Nov., 1903. No. 58882.

The Weight of a Flywheel Rim. R. T. Strohm. Explains the method of computing. 2000 w. Power—Nov., 1903. No. 58835 C.

Fuel Losses.

Fuel Losses in Steam Plants, and How to Determine Them. George H. Barrus. Outlines methods of testing and sources of waste that may be determined by observation. 3000 w. Cassier's Mag—Nov., 1903. No. 58895 B.

Furnace Gas.

Errors in Analyses of Furnace Gases Shown by Computation. William Kent. Mathematical demonstration. 1000 w. Stevens Ind—Oct., 1903. No. 59294 D.

Heating Plants.

Central Heating Plants at Indianapolis, Ind. W. K. Eldridge. Abstract of a paper read at meeting of the Am. Soc. of Munic. Imp. A report of plants operating in conjunction with electric lighting stations. 1200 w. Eng News—Nov. 5, 1903. No. 58870.

Inspection.

The Growth of the Hartford Company. A graphical analysis, with notes, showing the work done by the Hartford Steam Boiler Inspection and Insurance Company. 1200 w. Locomotive—July, 1903. No. 58809.

Oil Fuel.

Oil-Fired Furnaces. A. M. Bell. Considers some of the applications for which oil fuel is especially adapted, and gives illustrated descriptions of types of furnaces used. 2500 w. Cassier's Mag—Nov, 1903. No. 58896 B.

Reversing Gear.

The Woolf Reversing Motion. Frederick H. Stacey. An illustrated article explaining the functions and laws on which the working of a radial valve gear for traction engines depends. 1400 w. Power—Nov., 1903. No. 58834 C.

Steam Flow.

The Flow of Gases and Steam through Tubes of Variable Section (Die Stationäre Strömung von Gasen und Dämpfen durch Rohre mit Veränderlichem Querschuitt). H. Lorenz. With especial reference to the action in nozzles of steam turbines and similar machines. 2500 w. Zeitschr d Ver Deutscher Ing—Oct. 31, 1903. No. 59105 D.

Steam Pipes.

Notes on the Arrangement and Construction of Steam Pipes and Their Connections. Robert C. Monteagle. Points out some of the causes of failure, describ-

ing points in design, and considering material. Ill. 4000 w. Trans Am Soc Nav Archts & Marine Engrs, No. 3—Nov., 1903. No. 59039 D.

Stoking.

Kilroy's Stoking Indicator. An illustrated description of an electrical apparatus to aid in better and more regular stoking. 700 w. Elec Rev, Lond—Oct. 23, 1903. No. 58726 A.

Superheating.

The Generation of Superheated Steam (Die Erzeugung des Ueberhitzten Wasserdampfes). Dr. Otto Berner. A discussion of the construction of superheaters, with tabulated data of results of experimental researches. Two articles. 10,000 w. Zeitschr d Ver Deutscher Ing—Oct. 24, 31, 1903. No. 59102 each D.

Steam Alternator Working with Highly Superheated Steam. E. Kilburn Scott. A summary of results obtained by Prof. Ewing in tests upon a 300 I. H. P. single crank compound jet condensing engine. Ill. 1700 w. Tram & Ry Wld—Nov. 12, 1903. No. 59249 C.

Turbines.

Some Notes on Steam Turbo-Electric Generating Plants. George Wilkinson. Read before the Leeds Local Soc. of the Inst. of Elec. Engrs. Gives the leading characteristics of various types of turbo-generators, with suggestions from the writer's experience. 4800 w. Elect'n, Lond—Oct. 23, 1903. No. 58732 A.

The Steam Turbine Installation of the B. F. Goodrich Company. Illustrated description of a plant at Akron, Ohio, in which the steam turbine and electric motor are the important factors in the economical generation and use of power. 4800 w. Eng Rec—Nov. 7, 1903. No. 58837.

U. S. Navy.

Steam Engineering in the Navy. Extracts from the report of Admiral Rae, in which the needs of the principal navy yards are pointed out. 3800 w. Ir Age—Nov. 5, 1903. No. 58772.

MISCELLANY.

Aeronautics.

Recent Aeronautical Progress, and Deductions to be Drawn Therefrom, Regarding the Future of Aerial Navigation. Major B. F. S. Baden-Powell. Presidential address before the Aeronautical Society of Great Britain. 5000 w. Sci Am Sup—Nov. 21, 1903. No. 59030.

The Barton Airship. An illustrated description of the construction. 1800 w. Auto Jour—Nov. 14, 1903. No. 59095 A.

The Beedle Airship. Illustrations with brief description. 800 w. Auto Jour—Nov. 7, 1903. No. 58990 A.

The Mechanical Principles of Aeronautics (Die Mechanischen Grundgezetze der Flugtechnik). A. Budan. A general review of the mechanics of dirigible balloons and aeroplanes. Two articles, 6000 w. Zeitschr d Oesterr d Ing u Arch Ver—Oct. 16, 23, 1903. No. 59120 each D.

Refrigeration.

The Manufacture of Artificial Ice. Oswald Gueth. A lecture delivered before the Jas. Watt Assn. Illustrates and describes the methods used in the manufacture of artificial ice for commercial purposes. 2300 w. Engr, U S A—Nov. 2, 1903. Serial. 1st part. No. 58973 C.

Wood Chopping.

A New Hard Wood Chopping Plant. Illustrated description of a new machine for chopping the hardest woods, describing its action. 1200 w. Engr, Lond—Nov. 6, 1903. No. 59013 A.

MINING AND METALLURGY

COAL AND COKE.

Coal Feeding.

Coal Feeding Difficulties in Hoppers and Spouts. William L. Morris. Discusses defects in design, and other factors that enter into the maintenance of a uniform "dead fire line." Ill. 2000 w. St Ry Rev —Nov. 20, 1903. No. 59242 C.

Coal Storage.

Observations Upon the Sub-Aqueous Storage of Steam Coal. J. Macaulay. Reasons and suggestions in explanation of the seeming increase in calorific value of coal stored under water. 3500 w. Engr, Lond—Oct. 30, 1903. No. 58802 A.

Coking.

Reactions and Temperatures in By-Product Coke Ovens. Describes some of the peculiarities in the progress of coking through the charge. 1200 w. Ir & Coal Trds Rev—Oct. 30, 1903. No. 58907 A.

Great Britain.

The Coal Mining Industry of the United Kingdom. R. A. S. Redmayne. Professor Redmayne's third and concluding paper reviews the present economic conditions of

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coal mining in Great Britain, together with the questions of future supply and foreign competition. 3000 w. Engineering Magazine—Dec., 1903. No. 59167 B.

Natal.

Coal-Mining in Natal. Information from the report of C. J. Gray, Commissioner of Mines for Natal. 1800 w. Col Guard—Nov. 6, 1903. No. 59002 A.

New South Wales.

Coal-Mining in New South Wales. Information from the annual report of the output, value, etc. 2500 w. Col Guard—Oct. 23, 1903. No. 58727 A.

Production.

Coal Production and Consumption of the Principal Countries of the World. A statement of the production, value, etc., of coal in the five principal coal-producing countries of the world. 3000 w. Col Guard—Oct. 30, 1903. No. 58795 A.

Coal Production and Consumption. Editorial review of the returns from all the large industrial countries, recently published by the British Board of Trade. 1800 w. Engng—Nov. 13, 1903. No. 59077 A.

COPPER.

Commercial Copper.

See Electrical Engineering, Electro Physics.

Price.

The Price of Copper. Discusses the effect of the decision to close down the Montana mines. 1200 w. Engr, Lond—Oct. 30, 1903. No. 58806 A.

Refining.

Electrolytic Copper Refining. Wilder D. Bancroft. Abstract of a paper read at the Niagara Falls meeting of the Am. Elec. Chem. Soc. A report of tests made to determine the relation between voltage, current density and temperature for pure copper plates set definite distances apart in four solutions of compositions used in practice. Also other data. 1500 w. Eng & Min Jour—Nov. 14, 1903. No. 59230.

Siberia.

Mining in the Kirghiz Steppes. E. Nelson Fell. An illustrated article describing the country, its geology, the history of mining in the region, methods, etc., with a brief outline of the Yuspenski copper mine, which is the only one seriously developed. 5000 w. Eng & Min Jour—Nov. 14 & 21, 1903. Serial. 2 parts. No. 59225.

Smelting.

Copper Smelting at Anaconda. A. P. Mallon. A description of how the ores are treated. 1200 w. Pacific C Min—Nov. 14, 1903. No. 59069.

GOLD AND SILVER.

Assaying.

Assaying of Gold and Silver at the United States Mint. John W. Pack. An explanation of the methods employed. 3000 w. Min & Sci Pr—Nov. 14, 1903. No. 59239.

Black Hills.

Ore Deposits of the Northern Black Hills. J. D. Irving. Extracts from a paper read at the Am. Min. Cong. Describes the geology, deposits of gold-bearing rocks and gravels, the development, etc. 3000 w. Min Rept—Nov. 19, 1903. No. 59232.

British Columbia.

Alluvial Deposits of Horsefly, B. C. W. M. Brewer. Illustrates and describes the placer and hydraulic mines of this portion of the Cariboo district. 1200 w. Min & Sci Pr—Oct. 31, 1903. Serial. 1st part. No. 58818.

Hydraulic Mining on the Quesnelle. William M. Brewer. Describes this portion of the Cariboo mining district, giving details of operation and results obtained by hydraulic mining of these auriferous gravels. 2300 w. Eng & Min Jour—Oct. 31, 1903. No. 58776.

Through the Lardeau. An account of recent progress and present day conditions in the Trout Lake division, and about Fish River, and its creeks. 7400 w. Ill. B C Min Rec—Nov., 1903. No. 58925 B.

California.

The Cretaceous Auriferous Conglomerate of the Cottonwood Mining District, Siskiyou County, California. H. W. Turner. Describes the formations of this district. 3500 w. Eng & Min Jour—Oct. 31, 1903. No. 58774.

Classification.

Notes on Classification. T. Lane Carter and D. V. Burnett. Discusses classification in its relation to the cyanide process. Ill. 4500 w. Jour Chem, Met & Min Soc of S Africa—Sept., 1903. No. 59064 E.

Colloidal Gold.

On Colloidal Gold: Adsorption Phenomena and Allotropy. J. C. Blake. An investigation of garnet-colored solution of Colloidal gold with regard to the adsorption phenomena of the gold when precipitated by electrolytes, with observations on the apparent allotropy. 1800 w. Am Jour of Sci—Nov., 1903. No. 58695 D.

Concentration.

A System of Continuous Concentration of Ores by Oil. J. W. Van Meter. Illustrated description of the Van Meter-Boss system. 1400 w. Min & Sci Pr—Nov. 7, 1903. No. 58947.

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Cyaniding.

A New and Rapid Method of Detecting and Estimating Gold in Working Cyanide Solutions. James Moir. Describes the process. 2500 w. Jour Chem, Met & Min Soc of S Africa—Sept., 1903. No. 59065 E.

Cyaniding Sluices at Cobar (N. S. W.). F. Danvers Power. Describes the filter-press method adopted. Ill. 2000 w. Aust Min Stand—Oct. 15, 1903. No. 58993 B.

The Regeneration of Working Cyanide Solutions When Zinc Precipitation is used. Discussion of paper by A. F. Crosse. 7500 w. Jour Chem, Met & Min Soc of S Africa—Sept., 1903. No. 59062 E.

Dredge.

Prospecting Gold Dredge with Steel Hull. Describes a prospecting dredge of all steel construction, designed to clean up bedrock at 22 ft. depth, and to handle free material at the rate of 60 tons per hour. 1700 w. Eng & Min Jour—Nov. 7, 1903. No. 58851.

Estimating.

The Colorimetric Estimation of Gold in Cyanide Solutions. Henry R. Cassel. Describes an easy and quick method of estimating by eliminating the cyanogen present and then using the "Purple of Cassius" test. 1100 w. Eng & Min Jour—Oct. 31, 1903. No. 58778.

Ferrocyanides.

An Examination of Various Methods for the Estimation of Ferrocyanides. J. E. Clennell. A summary of the most promising of the methods examined in an investigation made. 5000 w. Eng & Min Jour—Nov. 7, 1903. No. 58848.

Kalgoorlie.

I. Grinding Machines Used at Kalgoorlie. II. Dry-Crushing and Roasting at Kalgoorlie. Two articles abstracted from a paper by W. Evav Simpson, describing the treatment of telluride ores. 4000 w. Eng & Min Jour—Nov. 14 & 21, 1903. Two parts. No. 59226.

Permanence in Depth in Kalgoorlie. H. C. Hoover. Abstract of paper on "The Future Gold Production of Western Australia," in the *Pro.* of the Inst. of Min. & Met., London. Briefly describes these deposits, their value, origin, etc., 900 w. Eng & Min Jour—Oct. 31, 1903. No. 58775.

Mexico.

Ancient and Modern Mexican Metallurgy. A. W. Warwick. The present article considers the patio process, and the results. 700 w. Min Rept—Nov. 12, 1903. Serial. 1st part. No. 58965.

Michipicoten.

Notes on the Michipicoten Gold-Belt. C. H. Clarke. An account of this Lake Superior region and its development. 2000 w. Eng & Min Jour—Nov. 14, 1903. No. 59228.

Montana.

The Elkhorn Mining District of Montana. Abstract and notes by Arthur Lakes of article by W. H. Weed in the Annual Report of the U. S. Geol. Survey. Silver, a little gold, copper, lead, etc. Ill. 2400 w. Mines & Min—Nov., 1903. No. 58741 C.

Moore Process.

The New Moore Process as Installed at the Consolidated Mercur Gold Mines. George Moore. An illustrated description of this process for the treatment of slimes. 1300 w. Min Rept—Nov. 12, 1903. No. 58964.

Nevada.

The Ore Deposits of Tonopah, Nevada. J. E. Spurr. An illustrated description of the geology, mineralization, occurrence, etc. The mines are worked for the silver, though other minerals of value are found. 1800 w. Eng & Min Jour—Nov. 21, 1903. No. 59231.

Placers.

Undercurrents for Saving Flour Gold and Platinum Sands. Dennis H. Stovall. Describes the system in use at the Royal Group hydraulic mines of Galice District, Oregon. Ill. 800 w. Min & Sci Pr—Oct. 24, 1903. No. 58755.

Production.

The Greatest Gold-Producing Mines. J. H. Curle. Brief outlines of the best producers, with table giving an approximate estimate of 30 of the greatest gold producing mines of the present. Three are in the United States. 1400 w. Eng & Min Jour—Nov. 7, 1903. No. 58847.

Quartz Milling.

Notes on the Common Practice of Quartz Milling on the Rand. Discussion of paper by Fraser Alexander. 4500 w. Jour Chem, Met & Min Soc of S Africa—Sept., 1903. No. 59066 E.

Sulphide Ores.

A Dry Process for the Treatment of Complex Sulphide Ores. H. Livingstone Sulman and Hugh Kirkpatrick Picard. Read before the Inst. of Min. & Met. Describes the application of the writer's process to these ores, giving just a brief sketch of other processes. 7500 w. Can Min Rev—Oct. 31, 1903. No. 58765 B.

Thunder Mountain.

Thunder Mountain Region, Idaho County, Idaho. Notes on the development work done and under way in the Thunder Mountain and Big Creek mining districts. 2200 w. Min Rept—Nov. 5, 1903. No. 58924.

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Thunder Mountain Region, Idaho County, Idaho. Continued account of important development work under way in this region. 2000 w. Min Rept—Nov. 12, 1903. No. 58967.

Witwatersrand.

The Witwatersrand Gold Deposits and Their Associated Rocks. Frederick H. Hatch. Discussion of papers by J. S. Curtis and G. A. Denny. Read before the So. African Assn. of Engrs. 2000 w. Eng & Min Jour—Nov. 7, 1903. No. 58849.

The Witwatersrand Ore Deposits. G. A. Denny. Abstract of discussion of a paper by J. S. Curtis, read before the So. African Assn. of Engrs. 3000 w. Eng & Min Jour—Oct. 31, 1903. No. 58777.

IRON AND STEEL.

Blast Furnaces.

The Blast Furnaces of Schneider & Co., at Cette (Les Haut Fourneaux Schneider et Cie. de Cette). An illustrated description of the large iron works at Cette, operated in connection with the other establishments of Schneider & Co. 5000 w. Revue Technique—Oct. 25, 1903. No. 59115 D.

New Blast Furnace Plant of the Toledo Furnace Co., at Toledo, Ohio. Illustrates and describes a well equipped plant for the production of foundry iron. 2800 w. Ir Trd Rev—Nov. 5, 1903. No. 58817.

Blow Holes.

Preventing Pipes and Blow Holes in Ingots and Castings. Dr. F. C. Weber. Describes the writer's work in this field, and comments on an article on this subject in *Stahl und Eisen*. 1700 w. Ir Age—Nov. 12, 1903. No. 58857.

Elba.

Blast-Furnace Plant on the Island of Elba (Hochofenanlage auf der Insel Elba). J. Nebelung. An illustrated account of the working of the extensive iron ore deposits on the island, with details of the furnaces and machinery of the new works at Portoferraio. Two articles. 6000 w. Zeitschr d Ver Deutscher Ing—Oct. 24, Nov. 7 1903. No. 59103. Each D.

Electric Installation of the Elba Iron Works (Installation Electrique des hauts Fourneaux de la Société Elba). Describing the power station, electric pumps, and general arrangement. Gas engines using waste furnace gases are used. 2000 w. Génie Civil—Oct 24, 1903. No. 59110 D.

Foundry Iron.

See Mechanical Engineering, Machine Works and Foundries.

Grading.

Features and Characteristics of Iron and Steel. R. G. Griswold. Illustrated article discussing what may be learned from the appearance of fractures, and considering the grades of cast iron, also wrought iron and steel. 2500 w. Power—Nov., 1903. No. 58831 C.

Improvements.

British Improvements in Iron and Steel Making. An address delivered before the Staffordshire Iron & Steel Inst., by Mr. Walter Macfarlane. 4700 w. Engr, Lond—Nov. 13, 1903. No. 59083 A.

Lackawanna Plant.

W. W. Scranton on the Lackawanna Plant. An interesting letter to the Scranton *Times*, largely in praise of the new plant at Buffalo. 1200 w. Ir Age—Nov. 10, 1903. No. 59018.

Open Hearth.

The Cost of Open-Hearth Steel as Affected by Using Blast Furnace Gas in Gas Engines, and Remarks on the Latest Improvements. Peter Eyermann. Gives some important points in relation to gas engines, and calculations, indicating how great economy may be affected. 6400 w. Jour Assn of Engng Soc—Sept., 1903. No. 59272 C.

Ore.

Treatment of Finely Divided Iron Ore. Prof. Léonce Fabre, in *Revue de Chimie Industrielle*. Describes the principal processes now followed. 1500 w. Sci Am Sup—Nov. 7, 1903. No. 58889.

Philippine Islands.

The Iron Mines of Angat, Philippine Islands. H. D. McCaskey. An illustrated article referring to iron deposits of value in the province of Bulacan, Central Luzon. 1200 w. Eng & Min Jour—Nov. 14, 1903. Serial. 1st part. No. 59229.

Rolling Mill.

See Mechanical Engineering, Machine Works and Foundries.

Rolls.

See Mechanical Engineering, Machine Works and Foundries.

Steel.

Manganese Steel (Aciers au Manganese). L. Guillet. A study of the different series showing the physical, chemical, and industrial properties. 6000 w. Bull Soc d' Encour—Oct. 31, 1903. No. 59124 G.

Steel Works.

Blast Furnaces and Steel Plant of the Clairton Steel Co., at Clairton, Pa. Illustrated detailed description of large works recently erected. 3000 w. Ir Trd Rev—Nov. 19, 1903. No. 59224.

Transformations.

The Allotropic Transformations of Iron and Its Alloys (Transformations Allotropiques du Fer et de ses Alliages). O.

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Boudouard. Data and results of experiments with numerous diagrams, tables, and a bibliography. 10,000 w. Bull Soc d' Encour—Oct. 31, 1903. No. 59125 G.

MINING.

Ankylostomiasis.

Ankylostomiasis. The first installment of a series of illustrated articles on the worm disease infecting mines of continental Europe. 3200 w. Col Guard—Nov. 6, 1903. Serial. 1st part. No. 59001 A.

Ankylostomiasis in Westphalian Colleries. J. S. Haldane. From a report to the Sec. of State for the Home Dept. Considers the source of the infection, the conditions affecting the spread, measures taken to combat the disease, the results, prevention, &c. 6400 w. Ir & Coal Trds Rev—Nov. 13, 1903. No. 59071 A.

Dikes.

Dikes and Intrusive Sheets. Explains these terms and the means of distinguishing, giving information of interest because of their frequent connection with ore deposits. 1200 w. Min Rept—Oct. 29, 1903. No. 58743.

Doors.

Automatic Shaft Doors (Selbsttä tige Schachtverschlüsse). H. Siede. Illustrating and describing the Münger form of sliding doors for mine shafts, operated automatically by the cage. 1000 w. Glückauf—Oct. 31, 1903. No. 59135 D.

Explosives.

Explosives on the Witwatersrand. T. Lane Carter. Facts illustrating the cost of dynamite before the war and at the present time, with information regarding other explosives. 1200 w. Eng & Min Jour—Nov. 7, 1903. No. 58850.

Hoisting.

Electric *versus* Steam Mine Hoisting Machinery. Frank C. Perkins. Describes installations in Europe, showing that while steam is generally used, electric hoists do the work equally well, and will probably be installed in new works. Ill. 800 w. Min Rept—Nov. 5, 1903. No. 58922.

Hoisting Plant and Steel Shaft House for the Oliver Iron Mining Co., at Ely, Minn. An illustrated detailed description of an interesting plant and its equipment. 3500 w. Eng News—Nov. 19, 1903. No. 59023.

Some Notes on Certain Underground Hoisting Problems on the Witwatersrand. A. W. K. Pierce. Describes the conditions to be met, considering the best method for this important hoisting work to be a combination of polyphase transmission, conversion to direct currents and the utilization of the conversion machinery for controlling the hoisting operations. 2800 w. Trans Am Inst of Elec Engrs—Oct., 1903. No. 59288 D.

Ignition.

Progress in Ignition of Mine Explosives (Fortschritte im Minenzündwesen). Johann v. Lauer. A review of the development of friction primers and electric igniters for mining explosives since 1886. Two articles. 3000 w. Oesterr Zeitschr f Berg ú Hüttenwesen—Oct. 24, 31, 1903. No. 59131 each D.

Leasing.

The Leasing System. Prof. Arthur Lakes. Describes a method of working mines which is operated on both large and small scales and is applicable to peculiar conditions. 2000 w. Mines & Min—Nov., 1903. No. 58742 C.

Mine Equipment.

Equipment of the Sultan Mine, Arizona. Charles E. Bunker. Begins an illustrated detailed description. 1400 w. Min & Sci Pr—Nov. 14, 1903. Serial. 1st part. No. 59240.

Mine Gases.

Some Mine Gases: Their Toxicology and Possible Connection with Miners' Phthisis. Discussion of a paper by A. Heymann. 13000 w. Jour Chem, Met & Min Soc of S Africa—Sept., 1903. No. 59063 E.

Mine Opening.

A Number Scheme for Mines. Matt W. Alderson. An explanation of system adapted to the needs of mine development. 1200 w. Min & Sci Pr—Oct. 24, 1903. No. 58754.

Rock Drills.

Fern's "Challenge" Sharpener for Rock Drills. An illustrated description of the machine and its operation. 1200 w. Engng—Oct. 23, 1903. No. 58734 A.

Shafts.

The Utilization of Cross Sections of Hoisting Shafts (Ueber die Ausmitzung des Querschnittes in Förderschachten). H. Stegemann. A discussion of the various arrangement of cages in circular shafts, in order to utilize the space to the best advantage. 5000 w. Glückauf—Oct. 17, 1903. No. 59134 D.

MISCELLANY.

Antimony.

See Electrical Engineering, Electrochemistry.

Bismuth.

The Metallurgy, Mineralogy, and Utilization of Bismuth. Dr. J. Ohly. Describes processes for the extraction of bismuth, giving information of its occurrence, etc. 1200 w. Min Rept—Nov. 5, 1903. Serial. 1st part. No. 58923.

Diamonds.

The Kimberly Diamond Mines. H. V. Conrad. Illustrations, with brief description of the De Beers Consolidated mines. 500 w. Ir Age—Nov. 19, 1903. No. 59017.

Electro-Metallurgy.

See Electrical Engineering, Electrochemistry.

Flint.

Flint, an Ancient Industry. Robert T. Hill. Brief account of the flint industry in England, with remarks on chalk and flint deposits. 1300 w. Eng & Min Jour—Nov. 7, 1903. No. 58846.

Lead.

Lead Smelting in Spain. Hjalmar Eriksson. Brief description, with illustration, of a plant serving as a general type for that country. 1100 w. Eng & Min Jour—Nov. 14, 1903. No. 59227.

The Rossie Lead Veins. C. H. Smyth, Jr. Notes on these old mines of St. Lawrence County, New York. 3700 w. Sch of Mines Qr—July, 1903. No. 59292 D.

Oil.

See Industrial Economy.

Platinum.

Mining Platinum in Southern Oregon. D. H. Stovall. Brief account of the methods for mining and saving platinum recently introduced. 700 w. Min Rept—Nov. 12, 1903. No. 58966.

Tin.

Tin and Its Occurrence—Mineralogy and Metallurgy. Dr. J. Ohly. Describes the characteristics of this metal and its occurrence in the United States and Alaska in the present article. 1200 w. Min Rept—Nov. 19, 1903. Serial. 1st part. No. 59233.

Zinc.

The Roasting of Zinc Blende (Die Röstung der Zinkblende). F. Kellermann Describing furnaces for roasting zinc ore and converting the resulting sulphur vapors into sulphuric acid. 1500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 31, 1903. No. 59133 D.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Acceleration.

Some Notes on Acceleration—Electric v. Steam. P. Walter d'Alton, and Dr. John Mannheim. A comparison of the systems, showing that speed and economy are in favor of electricity. 4400 w. Engr, Lond—Nov. 6, 1903. No. 58907 A.

Accidents.

Railroad Accidents—Year Ending June 30, 1903. Reviews the last bulletin of the Interstate Commerce Commission. 2800 w. R R Gaz—Nov. 20, 1903. No. 59217.

The Board of Trade Inspectors. Editorial review of the important points of report in the last Bluebook of the British Board of Trade. 2000 w. R R Gaz—Nov. 5, 1903. No. 58876.

Administration.

Colonial Railway Administration During Crises. Editorial discussion of the policy adopted by the Queensland Ry. Commissioner during the agricultural crisis of the past year, comparing with that of the New South Wales railway authorities. 2000 w. Engng—Nov. 6, 1903. No. 59005 A.

Disaster.

The Glasgow Train Disaster. Information from the report of Col. H. A. Yorke, in regard to the accident on July 27th. Also editorial. 2500 w. R R Gaz—Nov. 13, 1903. No. 58980.

Per Diem.

The Operation of the Rules for the per Diem Basis of Car Hire. F. A. Delano. Discusses some of the difficulties which have developed in the actual operation of the rules. 2200 w. Pro Iowa Ry Club—Oct. 20, 1903. No. 59060.

Tank Cars.

Requirements for Tank Cars Running Over the Pennsylvania Lines. Extracts covering the important requirements. 1100 w. R R Gaz—Nov. 27, 1903. No. 59268.

FINANCIAL.

Earnings.

New York Central & Hudson River. Showing how operating expenses have consumed gross earnings, giving statistics. Map. 1400 w. R R Gaz—Oct. 30, 1903. No. 58780.

New York, New Haven, and Hartford. Report of earnings, operating expenses, etc., for the last year. 600 w. R R Gaz—Oct. 30, 1903. No. 58782.

Reading Company. A report of earnings and operating expenses. 900 w. R R Gaz—Oct. 30, 1903. No. 58781.

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St. Louis Southwestern. Brief report of earnings, operating expenses, etc. 600 w. R R Gaz—Oct. 30, 1903. No. 58783.

MOTIVE POWER AND EQUIPMENT.

Bearings.

Improved Alloys for Car Bearings. Editorial reviewing briefly the history of the development of these alloys, and calling attention to the importance of lead. 1000 w. Ry Age—Oct. 30, 1903. No. 58751.

Brakes.

Fitting the Westinghouse Brake to the Bogies of the Locomotives of the Belgian State Railways. F. Matthei. Describes an arrangement being tried as an experiment upon an express engine. 1600 w. Bul Internat Ry Cong—Oct., 1903. No. 58719 E.

Break-Downs.

Break-Downs. Joseph A. Baker. Discusses the easiest and quickest way of making temporary repairs to a disabled locomotive, with the few tools supplied. 2000 w. Loc Engng—Nov., 1903. No. 58752 C.

Car Lighting.

Railway Carriage Lighting by Incandescent Gas. Particulars of experiments made in France. Summary from articles in the *Revue Générale des Chemins de Fer*, and from *Génie Civil*. Ill. 1700 w. Jour Gas Lgt—Oct. 20, 1903. No. 58712 A.

Cars.

A Flat-Car for Heavy Castings. Illustrates and describes steel under frame flat cars, the largest capacity eight-wheel cars ever built. 600 w. R R Gaz—Nov. 13, 1903. No. 58979.

A New Type of Steel Hopper Car. Illustration with description of a decided departure from any designs in use. Built by the Wellman-Seaver-Morgan Co. 5000 w. Eng News—Nov. 5, 1903. No. 58869.

Hazards of Passenger Cars. An illustrated article considering recent advances in construction. Specially discusses the cars of the Illinois Central, and the Subway cars in New York City. 2800 w. Gunton's Mag—Oct., 1903. No. 58694 C.

Connecting Rods.

See Mechanical Engineering. Steam Engineering.

Couplings.

Automatic Car Couplers (Selbsttätige Kuppelungen für Eisenbahnfahrzeuge). H. Sauer. An account of the various automatic couplers submitted for use on the German railways, the hooks being of the M. C. B. type. Two articles, 10,000 w. Glasers Annalen—Oct. 15, Nov. 1, 1903. No. 59128 each D.

The Substitution of Automatic Couplings for Screw-Couplings. Mr. Weiss, in *Zeitung des Vereines*. Describes a system for the introduction of automatic couplers, discussing matters of construction. 2000 w. Bul Internat Ry Cong—Oct., 1903. No. 58721 E.

Draft.

Experiments with Stacks and Exhaust Pipes. Extracts from a paper by T. H. Symington, presented at meeting of the Richmond R. R. Club. Gives results of experiments made which are of interest and importance in proportioning exhaust nozzles to produce chimney draft in locomotives. 2500 w. R R Gaz—Oct. 30, 1903. No. 58779.

Draft Gear.

The Farlow Draft Gear. Illustrates and describes a new type of draft gear and attachment. 900 w. R R Gaz—Nov. 6, 1903. No. 58872.

Fireboxes.

Concerning Leaky Fireboxes. T. S. Reilly. Considers that the lowering of the percentage of firebox to total heating surface has been carried below desirable limits. General discussion. 10,000 w. Pro W Ry Club—Oct. 20, 1903. No. 59057 C.

Locomotive Boilers.

Special Features in the Design of Locomotive Boilers and Fireboxes. Charles S. Lake. Mr. Lake's third and concluding paper treats of recent advances in firebox construction in America and on the Continent. 2500 w. Engineering Magazine—Dec., 1903. No. 59166 B.

Locomotive Building.

Locomotive Building in Germany. A. von Borries. Illustrates and describes many recent types built in Germany, indicating the character of the engines of different works. 3500 w. Cassier's Mag—Nov., 1903. No. 58894 B.

Locomotive Design.

Recent Progress in the Design of Locomotive Front-Ends. W. F. M. Goss. An illustrated paper considering the distribution of draft, action of the exhaust jet, form of exhaust nozzle, etc., etc. 4500 w. Pro Cent Ry Club—Nov. 13, 1903. No. 59058.

Locomotives.

Canadian Pacific Locomotives from Germany. Illustrated description of a freight locomotive. 600 w. R R Gaz—Nov. 27, 1903. No. 59265.

Eight-Wheel Passenger Locomotive for the 'Frisco System. Drawings, illustrations and description. 500 w. Ry Age—Nov. 20, 1903. No. 59235.

Four-Cylinder Compound Locomotives. Alfred G. de Glehn. A general description

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of the de Glehn compound as now built, with discussion of the reasons that have conduced to its extended use. 2400 w. Engr, Lond—Oct. 30, 1903. No. 58801 A.

Heavy Freight Locomotive. Illustrated description of the 2-8-0 type of the L. S. & M. S. Ry., with information of interest relating to it. 1500 w. Am Engr & R R Jour—Nov., 1903. No. 58919 C.

Heavy Goods Engine for the Bengal-Nagpur Railway. Illustrating sectional drawings and brief description. 2500 w. Engr, Lond—Nov. 6, 1903. No. 59011 A.

Heavy Pacific Type Locomotives for the El Paso & Southwestern. Illustrated description of heavy engines for fast freight service. 500 w. R R Gaz—Nov. 6, 1903. No. 58874.

Mogul Locomotives for Japan, Kiushiu Railway. Illustration, sectional drawings, and general dimensions, with details of construction. 500 w. Ry Mas Mech—Nov., 1903. No. 58813.

Six-Coupled Express Engine for the Glasgow and South-Western Railway. Illustration, with brief description. 500 w. Engr, Lond—Nov. 13, 1903. No. 59084 A.

Tandem-Compound Consolidations for the Colorado & Southern. Illustrated description. 500 w. R R Gaz—Nov. 13, 1903. No. 58981.

Tandem Compound Express Locomotive—Russian Empire Railways. Explains the conditions for the construction of these machines, and the peculiarities of this design, giving an illustrated description. 2500 w. Engr, Lond—Oct. 23, 1903. No. 58738 A.

Ten-Wheel Locomotive for the 'Frisco. Illustrated description. 500 w. Ry Age—Oct. 30, 1903. No. 58749.

The Heaviest Locomotive Ever Built. Sections, with detailed description of heavy freight engines of the 2-10-2 type, for the A., T. & S. F. Ry. 900 w. Am Engr & R R Jour—Nov., 1903. No. 58917 C.

Two-Cylinder Compound Locomotives for the Wabash. Illustrated description of fast freight mogul engines. Also editorial. 1500 w. Ry Age—Nov. 13, 1903. No. 58942.

Motor Car.

Railway Motor Car for the Paris-Orleans Railway Company. An illustrated description of an experimental car which seems to give satisfaction. 1700 w. Engng—Oct. 23, 1903. No. 58733 A.

Piston Valves.

Handling Piston Valves. Jas. Spellen. The writer's views on the proper handling of piston valve engines. 1200 w. Ry & Engng Rev—Nov. 14, 1903. No. 59014.

Reciprocating Parts.

Disturbing Influences of a Locomotive's Reciprocating Parts. Abstract of a paper by Prof. v. Borries. Considers the disturbances due to the unbalanced moving parts. 6000 w. R R Gaz—Nov. 27, 1903. No. 59267.

Testing Plant.

Locomotive Tests at St. Louis in 1904. Editorial review of the bulletin describing the proposed work. 1500 w. R R Gaz—Nov. 27, 1903. No. 59269.

The Locomotive Testing Plant of the Pennsylvania R. R. at the St. Louis Exposition. Describes the organization and plan of work as set forth in a bulletin issued by the Pennsylvania System. 3500 w. Eng News—Nov. 26, 1903. No. 59261.

Wheel Loads.

Permissible Wheel-Load per Foot of Wheel Diameter and per Inch of Breadth of Railhead. Francis J. E. Spring. From the *Pro. of the Inst. of Civ. Engrs.* Also editorial. On the limits of wheel loadings in railway service. 3000 w. Eng News—Nov. 19, 1903. No. 59024.

NEW PROJECTS.

Arctic.

Arctic Railroading. A. S. Atkinson. Describes the conditions that must be met in railroad construction and operation, and some of the benefits already evident from the construction of the White Pass & Yukon Ry. 1700 w. R R Gaz—Nov. 13, 1903. No. 58983.

Berlin.

Recent Improvements in Railway Stations in the North of Berlin (Les Récent Agrandissements des Gares de la Région Nord de Berlin). An account of terminal improvements with especial reference to the Stettin station. 1800 w. 1 plate. Génie Civil—Nov. 7, 1903. No. 59114 D.

China.

Railway Making in China. Thos. M. Reid. An illustrated account of the Anglo-American development of Chinese transportation facilities. 3000 w. Engineering Magazine—Dec., 1903. No. 59161 B.

Extensions.

Extensions of the Buffalo & Susquehanna Railroad. Elisha Walker. Describes the extensions amounting to about 185 miles to accommodate coal traffic. 1600 w. Eng Rec—Nov. 21, 1903. No. 59206.

Improvements.

London and Brighton Railway Widening. The first of a series of articles describing interesting work in England in connection with widening main lines without interrupting traffic. Ill. 4500 w.

We supply copies of these articles. See page 637.

Engng—Oct. 30, 1903. Serial. 1st part. No. 58797 A.

Philippines.

Proposed Railways for the Philippines. Map, with description of the routes of railways surveyed on the island of Luzon. 4000 w. Ry Age—Nov. 13, 1903. No. 58943.

Railroads in the Philippines. An account of the improvements and new lines recommended by United States engineers. 1200 w. R R Gaz—Nov. 27, 1903. No. 59264.

Transcontinental.

The New Canadian Transcontinental Railway. Extracts from a statement of the views of Sir Sandford Fleming on the subject of this new line. 1000 w. Eng News—Nov. 5, 1903. No. 58868.

Trans-Siberian Ry.

Siberia and the Trans-Siberian Railway. Some interesting information in regard to this road and its construction. 700 w. U S Cons Repts, No. 1802—Nov. 16, 1903. No. 58989 D.

PERMANENT WAY AND BUILDINGS.

Blocking.

I. Should Frogs and Guard Rails Be Blocked? J. Harrington. II. Blocked Frogs and Guard Rails. J. L. Dawson. Two short papers discussing this subject. 2000 w. Pro Iowa Ry Club—Oct. 20, 1903. No. 59061.

Exchange Stations.

Railway and Canal Exchange Stations. Mr. Mazoyer. Illustrated detailed description of German interchange stations, and matters relating to them. 2000 w. Trac & Trans—Nov., 1903. No. 58903 E.

Freight House.

New Freight House for the Baltimore and Ohio. Illustrates and describes a large structure being built in Chicago, having features of exceptional interest. 800 w. Ry Age—Nov. 6, 1903. No. 58820.

Hamburg.

The Reconstruction of the Railway Connections in and about Hamburg (Die Umgestaltung der Eisenbahnanlagen in und um Hamburg). H. Caesar. An account of the important changes and reconstruction work which has been done at the railway terminals at Altona and Hamburg. 3000 w. Glasers Annalen—Oct. 15, 1903. No. 59127 D.

Location.

Notes on Railway Location in Forest Country. Moses Burpee. Considers the difficulties, the outfit needed, the methods, etc. 3400 w. Eng Rec—Nov. 7, 1903. No. 58845.

Maintenance.

Railway Maintenance-of-Way. H. J. Sliffer. Considers means of securing the best results with the least expenditure. Also discussion. 6000 w. Jour W Soc of Engrs—Oct., 1903. No. 59273 D.

Paint Shop.

The Essentials of a Modern Railway Paint Shop. W. O. Quest. Discusses the necessary capacity, equipment, etc. 2400 w. Pro Ry Club of Pittsburg—Nov. 27, 1903. No. 59302.

Reconnaissance.

Railroad Reconnaissance. Willard Beahan. Considers the principles and methods of work in determining the route and line. Discussion. 6800 w. Jour W Soc of Engrs—Oct., 1903. No. 59274 D.

Shops.

Enlarged Power Plant of the Chicago, Milwaukee & St. Paul Railway, at West Milwaukee. Especially describes the power plant for the enlarged shops. The machinery is electrically driven, the yards and shops lighted with arc and incandescent lamps. Exhaust steam is used for heating, and compressed air furnished. 2000 w. Eng Rec—Nov. 14, 1903. No. 58960.

New Locomotive and Car Shops. An illustrated description of the shop equipment and buildings of the Pittsburg & Lake Erie R. R., at McKees Rocks, Pa. 2000 w. Am Engr & R R Jour—Nov., 1903. Serial. 1st part. No. 58916 C.

The Oaklawn Shops of the Chicago & Eastern Illinois Railroad. An illustrated detailed description of these shops and their equipment. 5500 w. Eng Rec—Nov. 21, 1903. No. 59203.

Signaling.

Progress of Power Signaling in England. Charles H. Grinling. A review of the progress made in introducing automatic signals. The first were on the Liverpool Overhead Electric Railway, in 1893. 1800 w. R R Gaz—Nov. 6, 1903. No. 58875.

Signals and Signaling. George S. Hodgins. The present article gives a historical review of the art of signaling. 3000 w. Loc Engng—Nov., 1903. Serial. 1st part. No. 58753 C.

Three-Position, Separate Home and Distant, and Overlapping Automatic Block Signals. Report presented at meeting of Ry. Sig. Club. 1500 w. Ry Age—Nov. 6, 1903. No. 58819.

Spikes.

Increased Resistance of Spikes to Drawing, Produced by Means of Hard Wood Bushes. W. Fridericia. Report of a section at Stockholm. Explains experimental investigations which seem successful.

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2300 w. Bul Internat Ry Cong—Oct., 1903. No. 58718 E.

Station.

The New Union Railroad Station at Washington, D. C. An account of the advantages of the new location chosen, with illustrated general description of the station building. 2500 w. Eng Rec—Oct. 31, 1903. No. 58763.

Terminals.

History of the Grand Central Terminal, New York City. An interesting review of the early history of the New York Central and Hudson River Railroad. 2500 w. R R Gaz—Nov. 13, 1903. No. 58982.

Some Proposed Improvements in St. Louis Terminals. A. P. Greensfelder. Describes work being done and contemplated, at a cost of millions of dollars. 7000 w. St Louis Ry Club—Oct. 9, 1903. No. 59056.

Terminal Necessities. W. M. Prall. Considers the necessities of the service and the difficulties. 4500 w. St Louis Ry Club—Oct. 9, 1903. No. 59055.

Ties.

Timber Treating Plants. W. W. Curtis. Refers to the methods of treatment now in use, especially for railroad ties, and their cost, giving illustrated description of plants. General discussion. 7500 w. Jour W Soc of Engrs—Oct., 1903. No. 59276 D.

The Railway Tie Question. Gives abstracts of reports, addresses and discussion of this subject at the recent convention of the Roadmasters & Maintenance of Way Assn. in Kansas City. 3800 w. Eng News—Nov. 19, 1903. No. 59026.

The Tie Problem. With Special Reference to Concrete Ties. G. H. Kimball. Reviews past practice, discussing the question of unequal settlement because of eccentric pressure, and giving illustrated description of a two-part tie with parts rigidly connected, designed by the writer, made of concrete. The form of construction is given in detail, and advantages stated. Discussion. 1600 w. Jour W Soc of Engrs—Oct., 1903. No. 59277 D.

Tracks.

Delaware, Lackawanna & Western Track Elevation in Newark and Harrison, N. J. Illustrated description of important improvements. 1200 w. R R Gaz—Nov. 27, 1903. No. 59262.

Water Softening.

An Extensive Water Softening Installation. Begins a description of the plants of the Pittsburg & Lake Erie R. R., having a total capacity of 348,000 gallons per hour. 1500 w. Am Engr & R R Jour—Nov., 1903. Serial. 1st part. No. 58918 C.

MISCELLANY.

Argentine Republic.

The Argentine Railroads. Reviews the statistics of railroads as given in a recent volume issued by the Minister of Public Works. Maps. 1200 w. R R Gaz—Nov. 6, 1903. No. 58877.

Contagion.

Prevention of Contagion in Passenger Cars. Leroy M. Yale. Considers the liability of contagion remaining in a car after the departure of the contagious case. 2200 w. R R Gaz—Nov. 20, 1903. No. 59215.

New South Wales.

New South Wales Railways. Editorial review of causes of the deficit of the past year. 1700 w. Engng—Oct. 30, 1903. No. 58800 A.

STREET AND ELECTRIC RAILWAYS

Albula Line.

The Albula Line from Thusis to Saint-Moritz. H. Cox. Read before the Wurtemberg Dist. Soc. An illustrated description of a mountain railway having many bridges, tunnels, and difficult construction work. Map and profile. 2500 w. Bul Internat Ry Cong—Oct., 1903. No. 58722 E.

Brussels.

Brussels Electric Tramways. An illustrated description of the reorganized arrangements of the power supply for these lines. 1600 w. Elec Rev, Lond—Nov. 6, 1903. No. 58999 A.

The Central Station of the Brussels, Belgium, Tramways. Emile Guarini. Illustrated description. 1700 w. Elec Rev, N. Y.—Nov. 14, 1903. No. 58948.

Camden, N. J.

The System of the Camden & Suburban Railway Company. The first of a series of four articles describing in detail the methods of this company. The present article is devoted to a description of the physical condition of the system. Ill. 7300 w. St Ry Jour—Dec. 5, 1903. Serial. 1st part. No. 59457 C.

Comparison.

Tramway or Light Railway. W. Valentine Ball. Considers the relative advantages of the two systems. 4000 w. Trac & Trans—Nov., 1903. No. 58900 E.

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Convertible Car.

Novel Convertible Car. Illustrated description of a new car designed by Hermann Romünder, of Bloomsbury, N. J., having novel features. 900 w. St Ry Jour—Nov. 7, 1903. No. 58855 C.

Detroit.

The Detroit Group of Electric Railroads. An account of lines in sharp competition with steam railroads. 2500 w. R R Gaz—Nov. 27, 1903. No. 59266.

Electric Traction.

The Conestoga Traction System. An illustrated detailed description of a comprehensive system serving Lancaster, Pa., and the surrounding country. 4500 w. St Ry Jour—Nov. 7, 1903. No. 58853 C.

Extension.

San Mateo Extension of the United Railroads of San Francisco. An illustrated detailed description of a new line to give high-speed service, its equipment, etc. 3000 w. St Ry Jour—Oct. 31, 1903. No. 58773 C.

Fireproof Cars.

Fireproof Cars on the Central London. Illustrated description of motor cars to replace the locomotives formerly used. 900 w. St Ry Jour—Nov. 7, 1903. No. 58-854 C.

Freight.

Freight Business on Electric Railways. F. D. Hawks, in *The Gateway*. A valuable article, considering also the passenger side, and discussing what business should, and what should not, normally be sought by various classes of transportation lines. 1300 w. Ry Age—Nov. 20, 1903. No. 59236.

Glasgow.

The Glasgow Tramways. An examination of some points brought out in a discussion of the report of the Tramways Committee. 4700 w. Trac & Trans—Nov., 1903. No. 58902 E.

Glasgow and Its Tramways. Editorial discussion of the project of a private company to construct tramways in the vicinity, which is opposed by the Municipal Corporation. 2000 w. Engng—Nov. 27, 1903. No. 59423 A.

High-Speed.

High-Speed Trials on the Berlin-Zossen Electric Railway. Brief review of interesting features in these trials, and the results. Ill. 2000 w. Tram & Ry Wld—Nov. 12, 1903. No. 59248 B.

Incline Railway.

Electric Incline Railway at Mt. Beacon-on-the-Hudson. Frank C. Perkins. Brief illustrated description of a line 2,200 ft. long and having a vertical height of 1,200 ft. 1000 w. Elec, N. Y.—Nov. 11, 1903. No. 58921.

Interurban.

Cincinnati Interurban Development. The first of a series of articles giving an illustrated detailed description of this extensive system and its equipment, with its history. 3500 w. St Ry Jour—Nov. 21, 1903. Serial. 1st part. No. 59210 C.

Some Operating Data on the Wilkesbarre & Hazleton Ry. J. E. Wallace. Illustrates and describes physical features of the road, protection of third rail, new form of shoe, tests, etc. 6000 w. St Ry Rev—Nov. 20, 1903. No. 59243 C.

The Interurban Railway & Terminal Co. Illustrates and describes the lines and equipment of a company operating in and around Cincinnati, Ohio. 5500 w. St Ry Rev—Nov. 20, 1903. No. 59241 C.

Isle of Thanet.

Isle of Thanet Electric Tramways and Lighting Company. B. Pontifex. An illustrated description of the power equipment, and lines. 2700 w. Elec Engr, Lond—Nov. 20, 1903. No. 59360 A.

Jungfrau.

The Jungfrau Railway. An illustrated article showing the progress of this wonderful engineering work, and giving information concerning it. 2300 w. Sci Am—Nov. 21, 1903. No. 59029.

Magnetism.

Magnetism Applied to Traction. William P. Baer. Describes the application to the electric car, explaining the principles upon which it is based. Ills., also discussion. 4800 w. Pro Iowa Ry Club—Oct. 20, 1903. No. 59059.

Montana.

Some Features of the Butte, Mont., Electric Ry. J. R. Wharton. Illustrates and describes the line and equipment. 1500 w. St Ry Rev—Nov. 20, 1903. No. 59-245 C.

Motor Ventilation.

The Heating of Railway Motors. S. T. Dodd and M. C. Canfield. States what has already been done in the way of ventilated motors, and the probable tendency of the development of street-railway motors. 2500 w. St Ry Jour—Nov. 21, 1903. No. 59211 C.

Multiple Supply.

The Multiple Supply Electric Railway System. Describes an attempt to solve the problem of the use of electricity on roads now operated by steam, considering also objections to the system which has been tried in Germany. 2400 w. ,Elec Rev, Lond—Nov. 6, 1903. No. 59000 A.

Newcastle.

Triple-Expansion Engine for Newcastle

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Tramways. An illustrated detailed description of a recently completed engine for driving one of the generators. 1400 w. Enging—Nov. 27, 1903. No. 59422 A.

Paris.

The Metropolitan Railway of Paris. Paul Letheule. A fully illustrated account of the building, equipment, and operation of the underground electric railway of Paris. 3000 w. Engineering Magazine—Dec., 1903. No. 59163 B.

The Paris Metropolitan Railway (Die Pariser Stadtbahn). Ludwig Troske. A general account of the Paris underground railway, with maps and profile. Serial. Part I. 4000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Nov. 7, 1903. No. 59106 D.

Power Plant.

Everett (Wash.) Railway and Electric Co.'s New Power Plant. Illustrations, plan and cross-section, with description. 2700 w. Engr, U S A—Nov. 16, 1903. No. 59019 C.

Power Station.

The Underground Electric Railways Power-Station at Chelsea. Illustrations, with historic notes and outline description. 3300 w. Tram & Ry Wld—Nov. 12, 1903. No. 59247 B.

Shops.

Car Shops of the St. Louis Transit Co. Illustrated description of the shops and their equipment. 4000 w. St Ry Rev—Nov. 20, 1903. No. 59246 C.

The Repair Shops of the St. Louis Transit Company. An illustrated detailed description of these extensive shops and their equipment, with editorial. Many new features in labor-saving machinery. 6500 w. St Ry Jour—Nov. 14, 1903. No. 58951 C.

Signalling.

Automatic Signalling on the District Railway. Illustrated description of the first instance in Great Britain of an electric railway automatically signalled by means of track circuits. 2000 w. Engr, Lond—Nov. 27 1903. No. 59428 A.

Single-Phase.

Single-Phase Motors for Tractions. Dr. Giorgio Finzi. A discussion of this system, giving results of experiments, and comparing with other systems. 3000 w. Elec Rev, Lond—Nov. 6, 1903. Serial. 1st part. No. 58998 A.

Speed.

The Speed of Tramcars. Reviews the laws which govern speed in England. 1200 w. Engr, Lond—Nov. 6, 1903. No. 59010 A.

Stray Current.

Electrolysis Investigations at Richmond. Review of the Report of Dabney H. Maury, made after an examination of 101 lines of pipe. 1600 w. Eng Rec—Nov. 7, 1903. No. 58836.

Surveys for Electrolysis, and Their Results. D. H. Maury. Suggestions useful to superintendents of water-works whose duty it is to see that pipes are not destroyed. 5700 w. Am Gas Lgt Jour—Nov. 23, 1903. No. 59214.

Surface Contact.

Surface Contact Tramways at Wolverhampton. Illustrates and describes the Lorain system to be introduced on the new lines to be constructed, giving also facts regarding the advantages claimed. 2700 w. Tram & Ry Wld—Nov. 12, 1903. No. 59250 C.

Third Rail.

Melting Sleet on a Third Rail. W. A. Del Mar. Showing why a large amount of energy is required to heat the rail. 1200 w. Elec Wld & Engr—Nov. 21, 1903. No. 59220.

Tracks.

Reconstruction of Olive Street Tracks in St. Louis. An illustrated account of the reconstruction of an old cable track to an electric track without interfering with the traffic. 700 w. St Ry Jour—Dec. 5, 1903 No. 59458 C.

Trolley Omnibus.

Trackless Trolley in Scranton. An illustrated description of an experimental line recently constructed and under operation. 1700 w. St Ry Jour—Nov. 14, 1903. No. 58952 C.

Vesuvius.

Electric Railroad Up Mt. Vesuvius. Abstract translation from *Revue Generale des Chemins de Fer.* Illustrates and describes a rack rail line. 1100 w. R R Gaz—Nov. 27, 1903. No. 59270.

Vienna.

The Vienna Metropolitan Railway. Emile Guarini. The first of a series of articles giving an illustrated detailed description. 800 w. Sci Am Sup—Nov. 28, 1903. Serial. 1st part. No. 59336.

We supply copies of these articles. See page 637.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or twelve for $2.00, thirty-three for $5, and one hundred for $15.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.

Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* New York.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Feilden's Magazine. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Württ. Ver. f. Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Pacific Coast Miner. *w.* San Francisco.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wiener Bauindustrie Zeitung. *w.* Vienna.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Electrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Calendar.

A Calendar of Invention and Discovery. Compiled by John Cassan Wait. Size, 6 by 4½ in.; pp. 770; illustrations, 12. Price, pocket-book form, cloth, $1; wall or desk form, 60 cents. New York: McGraw Publishing Co.

Each page of reading matter of this calendar contains brief biographies of two persons who have made notable contributions to the industrial progress of the world, and gives a short account of the discoveries or inventions made or other great work done by them. Besides this, there are appropriate poetical selections and a chronological list of some of the important events connected with the invention or discovery described. Opposite each printed page is a blank one for memoranda and diary. There are indexes of persons, of things described and of the poetical quotations, so that the calendar becomes a handy book of reference. By the arrangement of the matter, a great deal of valuable information is imparted in an interesting and agreeable manner, and for this reason and also as a convenient and entertaining diary and calendar it will appeal with particular force to those who are doing the progressive work of the world.

Engineering Age.

The New Epoch as Developed by the Manufacture of Power. By George S. Morison. Size, 7 by 5 in.; pp. 134. Price, 75 cents. Boston and New York: Houghton, Mifflin & Co.

The late Mr. Morison was pre-eminently qualified to be a leader in the engineering age which is now beginning, or rather, which has now begun. He was not only a trained technical man, who designed and carried out some of the great engineering works of the present generation, but he was also a man of broad and liberal mind, able to appreciate the work of men of other callings and to take that comprehensive view of the world and its varied activities, which finds expression in the present interesting and suggestive little volume. "The general idea which runs through the book was first suggested to the author while reading his classmate John Fiske's work entitled 'The Discovery of America,' in which the series of ethnical periods among prehistoric men is elaborated. The fact that the world is now entering on a new epoch of the same nature is the fundamental idea of the writer." This idea was developed and enlarged upon in several addresses and an essay, which have been recast to form some of the chapters of the present book. Other chapters are substantially new, and the whole manuscript was completed in the early part of 1898, but, owing to several causes, publication was delayed until after Mr. Morison's death, which occurred rather suddenly last July. The "new epoch" is characterized by the ability of man to manufacture power. The manufacture of power is more far reaching in its effects than any of the great steps of civilization which preceded it. It is exerting the most profound influence in every department of human activity, and when its age is firmly established we shall have practically a new world, in which the quickening and controlling spirit will be that of the engineer.

Geography.

American History and Its Geographic Conditions. By Ellen Churchill Semple. Size 9 by 6 in.; pp. 466; maps. Price $3. Boston and New York: Houghton, Mifflin & Company.

The relation of history to physical conditions is too often overlooked, and events which are assumed to be due to political actions might far better be traced back in many instances to geographical reasons. Taking this viewpoint of the development of the United States, Miss Semple has prepared a very interesting and valuable work, one which will bear careful reading and study. Starting with the settlement on the Atlantic coast, the influence of the rivers upon early exploration and settlement is considered, modified as it necessarily was by the Appalachian barrier. Following upon the period of settlement, the influence of geography upon the operations of the war of 1812, and upon the expansion into the far West is shown to have

been most marked, while the relation of geography to immigration, to the location of cities and of railways is included. The effect of the development of the Pacific coast on the growth of the United States as a world power follows, and the line of study thus indicated may aid in examining the direction of future possible development. Each chapter of the book is accompanied with an excellent bibliography, this both adding to its value, and indicating sources for further information. A number of excellent special maps are included.

Lubrication.

Friction and Lubrication. A Handbook for Engineers, Mechanics, Superintendents and Managers. By William M. Davis. Size, 8¼ by 5¾ in.; pp. v, 225; figures, 60. Price, $2. Pittsburg: The Lubrication Publishing Co.

The lubrication of machinery has the greatest influence upon its economical operation, and it is therefore most necessary that those in charge of engines, rolling stock and all kinds of machines should have a proper understanding of lubricants and the best methods of applying them. The present book bears evidence of the first-hand experience of the author, and is written and illustrated in a way which will appeal to practical men. There are sections on the testing of oils; the lubrication of the various parts of steam engines, such as cylinders and valves; the lubrication of gas and gasoline engines, air-compressing machinery, locomotives and railway cars, automobiles, street railway cars, marine engines, mining machinery, refrigerating machinery and textile-fabric machinery; self-oiling bearings; oiling devices and appliances, oil filters and automatic oiling systems; oil house methods, costs, records and tools; and on many other details of lubrication practice which will be found useful to all engaged in the operation of machinery.

Works Management.

The Factory Manager and Accountant. By Horace Lucian Arnold. Size, 9½ by 6½ in.; pp. vii, 431; illustrations, 250. Price, $5. New York and London: The Engineering Magazine.

The vital importance of sound works management is getting to be generally understood, and is acknowledged by all the abler directors and superintendents of manufacturing establishments. But there is still some uncertainty as to the proper methods for securing the highest efficiency and economy, and while the broad lines of factory management are becoming more clearly defined, there is a diversity of opinion as to the details. It is most probable that each establishment must develop the detailed methods best suited to its peculiar needs, but in order to do this successfully and economically, and with the least possible loss of time and energy in experiment, it becomes necessary to learn what has already been done under similar circumstances and to profit by the experience of others. The present book is designed to give just this information, as it describes in detail the actual methods used in some of the most successful American manufacturing establishments. Several complete systems of factory record and accounting forms are given, both the costing and commercial blanks being accurately reproduced in arrangement, and each one having the actual size in inches given, together with its color and the material on which it is printed. The commercial and costing accounting systems are so closely related in the best modern factory practice that neither can be fully and entirely comprehended without a knowledge of the other, and in some instances the same single form is used by both the cost-keeper and the commercial accountant, so that it cannot be fully described without reference to both its functions. The reader is thus enabled to reproduce any form here shown, and apply it in his own practice, and he may also trace its action and effects in relation to the entire accounting of the factory, and can compare his own practice with that of other managers, cost-keepers or accountants. The experienced and successful factory manager is fully aware of the importance of adapting each form blank perfectly to its intended uses, and well knows the tedious and costly experiments which invariably precede that final perfecting of a form before its record of dates and procedures can be made with the least possible clerical labor, while giving the best and clearest summary of performance; and managers who are satisfied with their own methods and results will study with deep interest the means employed by others to obtain similar effects. The manager who is not perfectly satisfied with his system, and who is aware that his accounting costs more than it should, and fails to give information in such complete detail as to clearly point the way to highly desirable savings which he believes possible, cannot fail to find in the present volume hints and examples of the greatest value, showing the exact means by which others have reached the ends he himself wishes to attain.

BOOKS RECEIVED.

Change Gear Devices. By Oscar E. Perrigo. Price, $1. New York: The Derry-Collard Co. London: The Locomotive Publishing Co., Ltd.

Kalender für Elektrochemiker, sowie technische Chemiker und Physiker. 1904. By Dr. A. Neuburger. Price, 4 marks ($1.25). Berlin: M. Krayn.

NEWS SUPPLEMENT

The Engineering Magazine—January, 1904

Coming Society Meetings.

AMERICAN ASSOCATION FOR THE ADVANCEMENT OF SCIENCE. Sec.: Prof. L. O. Howard, Cosmos Club, Washington, D. C. Annual meeting, Dec. 28-Jan. 2, at St. Louis.

AMERICAN ECONOMIC ASSOCIATION. Sec.: F. A Fetter, Ithaca, N. Y. Annual meeting, Dec. 29 to Jan 1, at New Orleans.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Sec.: Ralph W. Pope, 95 Liberty St., New York. Next meeting, Jan. 29. Papers on Alternating Current Railway Motors.

AMERICAN INSTITUTE, POLYTECHNIC SECTION. Sec.: George Whitefield, Jr., 19 W. 44th St., New York. Meetings on first and third Thursdays of each month, from October to May, inclusive.

AMERICAN RAILWAY ASSOCIATION. Sec.: W. F. Allen, 24 Park Place, New York. Next meeting, April 27, at New York.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION. Sec.: L. C. Fritch, Monadnock Block, Chicago. Annual meeting, March 15-17, at Chicago.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 27-29, Saratoga Springs, N. Y.

AMERICAN SOCIETY OF CIVIL ENGINEERS. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August. Annual meeting, Jan. 20.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS. Sec.: W. M. Mackay, 12 W. 31st St., New York. Annual meeting, Jan. 19-21, at New York.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Sec.: Prof. F. R. Hutton, 12 W. 31st St., New York. Next meeting in May, at Chicago.

ARCHITECTURAL LEAGUE OF AMERICA. Sec.: J. B. Nettleton. Next meeting, April or May, at Pittsburg.

BOSTON SOCIETY OF CIVIL ENGINEERS. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on fourth Wednesday in January and on third Wednesday of other months, except July and August.

BROOKLYN ENGINEERS' CLUB. Sec.: J. Strachan, 191 Montague St. Regular meetings on second Thursdays of each month.

CANADIAN RAILWAY CLUB. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month.

CANADIAN SOCIETY OF CIVIL ENGINEERS. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. The General Section and the Electrical, Mechanical and Mining Sections meet on different Thursdays.

CENTRAL RAILWAY CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Fridays of Jan., March, May, Sept. and Nov., Hotel Iroquois, Buffalo.

CHICAGO ELECTRICAL ASSOCIATION. Sec.: W. B. Hale, Monadnock Building. Regular meetings on first and third Fridays of each month, from October to May.

CIVIL ENGINEERS' CLUB OF CLEVELAND. Sec.: Joseph C. Beardsley, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

ENGINEERING ASSOCIATION OF THE SOUTH. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

ENGINEERS' CLUB OF CHICAGO. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

ENGINEERS' CLUB OF CINCINNATI. Sec.: J. F. Wilson, P. O. Box 333. Regular meeting on third Tuesday of each month.

ENGINEERS' CLUB OF COLUMBUS (OHIO). Sec.: H. M. Gates, 12½ North High St. Regular meetings on first and third Saturdays of each month.

ENGINEERS' CLUB OF MINNEAPOLIS. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month.

ENGINEERS' CLUB OF PHILADELPHIA. Sec.: J. O. Clarke, 1122 Girard St. Regular meetings on first and third Saturdays of each month, except July and August.

ENGINEERS' CLUB OF ST. LOUIS. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays.

ENGINEERS' SOCIETY OF WESTERN NEW YORK. Sec.: H. B. Alverson, 533 Ellicott Square, Buffalo. Regular meetings on first Tuesday of each month.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

FRANKLIN INSTITUTE. Sec.: Dr. Wm. H Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. General section meetings every Thursday.

HONOLULU ENGINEERING ASSOCIATION. Sec.: G. F. Bush, Hololulu, Hawaii.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS. Sec.: E. E. R. Tratman, Monadnock Block, Chicago. Annual meeting, Jan. 20-22, at Champaign.

INDIANA ENGINEERING SOCIETY. Sec.: C. C. Brown, Indianapolis. Annual meeting, Jan. 14-16, at Indianapolis.

IOWA RAILWAY CLUB. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

LOUISIANA ENGINEERING SOCIETY. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

MASTER CAR BUILDERS' ASSOCIATION. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 22-24, Saratoga Springs.

MICHIGAN ENGINEERING SOCIETY. Sec.: F. Hodgman, Climax, Mich. Annual meeting, Jan. 12-14, at Lansing.

MONTANA SOCIETY OF ENGINEERS. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturday in each month.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Sec.: Ernest H. Davis, 136 Liberty St., New York. Annual convention in May, at Boston.

NEW ENGLAND RAILROAD CLUB. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, at Pierce Hall, Copley Square.

NEW YORK ELECTRICAL SOCIETY. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays, at the American Institute, 19 W. 44th St.

NEW YORK RAILROAD CLUB. Sec.: F. M. Whyte, Grand Central Station, N. Y. City. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

NEW YORK STREET RAILWAY ASSOCIATION. Sec.: W. W. Cole, Elmira. Annual meeting, Sept., at Utica.

NORTHWESTERN ELECTRICAL ASSOCIATION. Sec.: Thos. R. Mercein, Milwaukee. Annual convention, Jan. 20, at Milwaukee.

NORTH-WEST RAILWAY CLUB. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

PACIFIC COAST ELECTRICAL TRANSMISSION ASSOCIATION. Sec.: Geo. P. Low, 237 Cherry St., San Francisco. Annual convention, third Tuesday in June. Intermediate meetings subject to call.

PACIFIC COAST RAILWAY CLUB. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at San Francisco and other cities.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS. Sec.: G. F. Cotterill, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

RAILWAY CLUB OF PITTSBURG. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg Pa. Regular meetings on fourth Friday of each month, at Hotel Henry.

RAILWAY SIGNAL ASSOCIATION. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov.

RICHMOND RAILROAD CLUB. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

ROCKY MOUNTAIN RAILWAY CLUB. Sec.: M. M. Currier, Colorado City. Regular meetings on first Saturday after the 15th of each month, at Union Depot, Denver.

ST. LOUIS RAILWAY CLUB. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

SOCIETY OF CHEMICAL INDUSTRY, NEW YORK SECTION. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, at Chemists' Club, 108 W. 55th St.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov., at Atlanta.

TECHNICAL SOCIETY OF THE PACIFIC COAST. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

TEXAS RAILWAY CLUB. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

WESTERN RAILWAY CLUB. Sec.: Jos. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

WESTERN SOCIETY OF ENGINEERS. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

—Mr. H. F. J. Porter, who has been associated with Westinghouse interests since the first of the year and has held the position of Assistant Manager of the Publishing Department, with offices in East Pittsburg and 10 Bridge Street, New York, has been made Second Vice-President of the Nernst Lamp Company, of which enterprise Mr. George Westinghouse is President, with the duties of General Manager and with headquarters at Pittsburg. He assumed charge on December 1st. This appointment does not affect Mr. Porter's relations with the Publishing Department at the present time.

—Mr. Walter H. Whiteside, the Manager of the Detail and Supply Department of the Westinghouse Electric & Manufacturing Company, has also been made the General

Manager of the Sawyer-Man Electric Company, and has added the duties of this new office to his former ones. Few men are better known than Mr. Whiteside in the electrical business. He has been connected with electrical trade interests for nearly twenty years, and during that time has extended his acquaintanceship to every part of the country and cemented friendships wherever he went.

—Mr. Frank T. Craven has resigned his position with the C. J. Field Conduit Company to represent the American Conduit Company, of 170 Broadway, New York, Chicago and California.

Industrial Notes.

—The American Society of Mechanical Engineers held one of the sessions of its annual December meeting at Hoboken, N. J., in the new auditorium of Stevens Institute of Technology. There was a peculiar appropriateness in this, as the first formal meeting of the Society was held at Stevens Institute, in 1880, and, probably, in the room which occupied the site of the new auditorium. This fine hall, which was finished just before the latest visit of the Mechanical Engineers, will comfortably accommodate about 700 persons, on the main floor and in the gallery. There is a good-sized and well arranged stage, with space in front for an orchestra, the acoustic properties of the hall are very satisfactory, and its decorations are in excellent taste. The Mechanical Engineers opened the auditorium with one of their regular morning sessions, at which papers were read and discussed, and afterwards they were escorted through all the departments of Stevens Institute by student guides. Luncheon was served in the Carnegie Laboratory of Engineering, and in the afternoon the members of the Society and their friends re-assembled in the auditorium, where Dr. Hans Goldschmidt, of Essen, Germany, lectured on "Alumino-Thermics," or the production of high temperatures by burning aluminum, and their applications to engineering and metallurgy, illustrating his address with many striking experiments.

—The "Circolo Enofile Italiano," a society of wine growers and distillers, of Rome, announce on the occasion of their annual exhibition, an international competition of apparatus utilizing alcohol, such as motors, automobiles, motor cycles, lamps, heating apparatus, etc. This exhibition and competition will take place in Rome, from February 6 to February 16, 1904. Every facility will be offered to intending exhibitors and competitors, and gold, silver and bronze medals will be given to the winners in the various classes.

—The Pennsylvania Railroad Company will design and cause to be constructed a suitable plant for testing locomotives, and, in co-operation with the Department of Transportation Exhibits, will install this plant at St. Louis. The plant will be ready for preliminary running by the first of March next, and in perfect running condition by the first of May, at which time formal work will commence. The purpose of the whole work is to be comprehensive and the endeavor will be to determine by the use of locomotives presenting different characteristics, the effect of the latter upon the economic performance, and the limits of the tractive power and boiler capacities. The Pennsylvania Railroad System will organize and maintain, under the direction of its Engineer of Tests, a staff of laboratory attendants and computors, to the end that the plant and the locomotives thereon may be safely and properly operated and the experimental data promptly handled. It will also provide supplies of fuel and oil and will meet all other fixed charges incident to the progress of the work. The Pennsylvania Railroad System, having called to its aid an Advisory Committee to assist in all matters of scientific interest, will in consultation with this Committee make selection of locomotives to be tested, determine conditions under which tests are to be run, specify as to the observations to be taken and the methods to be employed, and determine the manner in which the data shall be handled and the form in which the final results shall be presented. Further information may be obtained from F. D. Casanave, special agent of the Pennsylvania Railroad System, 910 Penn Square Building, Philadelphia.

—The Electric Club, of Pittsburg, announces that it will issue an illustrated monthly magazine to be styled *The Electric Club Journal.* The first number will appear February 1, 1904. The immediate

purpose is to put into permanent form the engineering papers and technical discussions that form a regular part of the work of The Electric Club. Many of the papers will be written by the engineering staff of a leading electric company, and much of the material will pertain to the latest apparatus and to the newest problems in engineering work. This matter will be published in a form suited to the needs of intelligent young men. The circulation of *The Electric Club Journal* is not restricted to the members of the Club, but the privilege of subscribing is extended to others.

—The Brown Corliss Engine Co., of Corliss, Wis., are manufacturing a full line of sawmill machinery, and have opened a special department for this class of machinery in the Wells Building, Milwaukee, in charge of Theo. S. Wilkin. They are also about to complete a contract with a foreign corporation to handle a full line of blast-furnace gas-engines. These lines will be carried on in connection with their Corliss-engine and rolling-mill work.

—The Reeves Engine Company are installing two of their vertical cross compounds in the new plant of the Megargee Paper Company at Modena, Pa. The larger is a 650-H. P. engine, designed for direct connection to the main shaft of the mill, and on this account the closest regulation is required. The smaller engine is to operate the electric plant.

—The New York Continental Jewell Filtration Co. have recently sold pressure and gravity filters to the following: F. J. F. Lovejoy, Pittsburg; Fleischmann & Co., New York; White Swan Laundry, Wheeling, W. Va.; City of Winston, N. C.; Salem Water Supply Co., Winston-Salem, N. C.; Springfield Gas Light Co., Springfield, Mass.; L. L. Brown Paper Co., Adams, Mass.

—In no branch of government service has the matter of ventilation been given such serious consideration as in the navy. The construction of the modern vessel renders it extremely difficult to secure proper ventilation in some portions below the water line. Noticeable for its novelty, among the various methods used to properly ventilate such places is the portable ventilating set, consisting of a small exhauster of the Monogram type directly connected to an enclosed electric motor. It is very light, moves a large body of air, and is provided with handles for carrying from place to place, thus enabling the crew to work in any portion of the vessel with comfort. It is but one of the many types of blowers manufactured by the B. F. Sturtevant Co., of Boston, Mass.

—The American Steam Gauge & Valve Mfg. Co. have again been compelled to seek new quarters, owing to the increase of their business, and are at present removing their entire plant and offices from Bismarck Street, Roxbury District, to the large brick buildings, 208-220 Camden Street, Boston, Mass. The buildings have floor space of 85,000 square feet. The Mowry & Phillips foundry department will also be removed from South Boston, and every branch of the business consolidated at the Camden Street factory. The new plant will afford the American Steam Gauge & Valve Mfg. Co. more than double the present capacity, and will be employed in producing their valves, gauges and indicators, and also special metals and foundry work in the Mowry & Phillips department.

—The Indicator Contest held by the Eagle Oil & Supply Co., 104 Broad Street, Boston, Mass., closed December 12th. It was participated in by hundreds of engineers from all over the country, and great interest was taken. Mr. J. P. Kennah, 13 Holden Street, Dorchester, Mass., was the lucky engineer, and will enjoy the pleasure of using one of the finest Robertson-Thompson indicators.

—The Erie Railroad Company has issued a convenient pocket map covering some of the western part of New York and Pennsylvania and the eastern part of Ohio, a district rich in coal, oil, natural gas and water power, and to which comes the iron ore from Lake Superior, so that it is a commanding territory for the manufacture of iron and steel, and a fine location for other industrial establishments. The Erie Railroad covers this region with its main line and many branches, and full information to manufacturers and others will be furnished by its industrial commissioner, Luis Jackson, 21 Cortlandt Street, New York.

—The Vulcan Iron Works Co., of Toledo, Ohio, the manufacturers of elevator, bucket and dipper dredges, excavators, boiler

fronts, etc., state that the reports that they had shut down, owing to lack of orders, are untrue in every particular. On the contrary, they have 150 or more men in steady employment and are getting more than the usual number of inquiries at this season for steam shovels and dredges, and their prospects for the spring trade are bright.

—The Wright Manufacturing Company, of Detroit, recently opened a New York office and salesroom at 159 Centre Street, corner of Walker Street, with Mr. James H. Pearson in charge. A complete line of the Wright Company's steam specialties will be carried in stock, including the "Wright" and the "Victor" improved safety water columns, "Emergency" high-pressure steam traps, "Victor" low-pressure steam traps, "Cyclone" exhaust heads, etc. This company report a greater demand than ever before for their goods, but they are able to keep abreast of orders, as their shop facilities were considerably enlarged a few months ago.

—The Helmick Foundry-Machine Co., of Fairmont, W. Va., the manufacturers of coal and coke plant equipments, mine cars, castings, etc., announce the completion of their new foundry and smith shop, which they have enlarged and improved, so that they are now better prepared than ever before to take care of their large and growing trade.

—The Watt Mining Car Wheel Co., of Barnesville, Ohio, have established a Chicago office, in the Old Colony Building, under the management of Mr. Ira E. Stevens, in order to more efficiently handle their business for the States of Indiana, Illinois, Iowa, Michigan, Minnesota, Missouri, North and South Dakota, and Wisconsin.

—The Federal Manufacturing Company, Diamond Chain Factory, of Indianapolis, state that the form of guarantee adopted by American manufacturers of chains for bicycles, motor cycles and automobiles is as follows: "We will replace such chains as in our judgment show defects in workmanship or material, provided same are returned to us for inspection, transportation charges prepaid. We agree to prepay return transportation charges to consignor on all replacements. On account of the various conditions under which chains are used and cared for, we cannot guarantee the certain performance of any chain, and will not replace chains or parts which have been used. Customers should inspect chains as soon as received, and report any supposed defects or complaints before returning same."

—The Otis Elevator Company will install in the twenty-five story building of the International Banking Corporation, 60 Wall Street, eight hydraulic passenger elevators and two electric freight elevators.

—A. Leschen and Sons Rope Co., whose home office is 920-932 North First Street, St. Louis, and who have branch offices in New York, Chicago and Denver, have the legend, "We pull for Leschens," on the large leather collars of the horses attached to the wagons in which they deliver their reels and coils of Hercules and Patent Flattened Strand and all other kinds of wire rope. A. Leschen & Sons Rope Co. also manufacture and erect aerial wire rope tramways of every description; likewise underground and surface wire-rope haulage plants. Their engineers in charge of the different departments have had years of experience and are thoroughly competent.

—The Crocker-Wheeler Company, of Ampere, N. J., has established headquarters for the Southern representative of its Washington Office, Mr. S. M. Conant, at 425 Empire Building, Atlanta, Ga.

—An extensive pump-manufacturing plant, the largest in this country, and probably in the world, is now under construction at Harrison, N. J. It is to be occupied by the firm of Henry R. Worthington, who employ about 3,000 men in their present works at South Brooklyn, L. I., and Elizabethport, N. J. The new plant at Harrison will accommodate from 4,000 to 5,000 men and will cost in the neighborhood of two million dollars. It consists of a main machine shop with side galleries over 1,006 feet long, an erecting shop 592 feet long and of the same section as the machine shop, and a high erecting shop, 210 feet in length and four galleries in height in the side bays connecting the two shops. The main foundry is 600 feet in length and there is also a special foundry for small work, 410 feet in length, with a building 200 by 60 feet in size for cleaning castings connecting the two. The pattern building is four stories high and 550 feet long and is divided by wire walls into four sections.

The north section will be used for offices and drafting rooms, the adjoining section for the pattern shop, and the balance of the structure for pattern storage. The power house, which will be equipped with the most modern boilers, engines and generators, is a building 172 by 102 feet. Electric power distribution is to be employed throughout, and the grounds will be illuminated by electric arc lights. There are many other buildings which will be used for packing, storing and shipping goods, etc. The buildings are so arranged that additions can be built when the work demands it. All will be connected by a complete system of railroad tracks entering the ends of the buildings and placing the works in direct communication with the Delaware, Lackawanna & Western, the Erie and the Pennsylvania Railroad Systems. The new plant will be devoted entirely to the manufacture of water-works machinery, water meters, cooling towers, condensers, feed-water heaters, centrifugal pumps and steam pumps of all kinds.

—The Association of Portland Cement Manufacturers recently held its second annual meeting in New York, where much business of importance was successfully transacted. Reports were received from committees appointed to confer with other societies in the matters of standard tests and specifications for cement and for concrete-steel construction, and uniform contracts between manufacturers and dealers and manufacturers and consumers. A resolution was adopted that the members of the Association should close their mills for six weeks or more, between December 1 and April 1, in order that necessary repairs may be made, many of the mills having been in continuous operation for the last two years. The Association will erect a fine building at the St. Louis Exposition. Robert W. Lesley, of the American Co., retired from the office of president and was succeeded by J. B. Loher, of the Vulcanite Co.; A. F. Gerstell, of the Alpha Co., formerly secretary, was elected vice-president; E. M. Young, of the Lehigh Co., formerly treasurer, was elected secretary, and E. R. Ackerman, of the Lawrence Co., becomes treasurer. The new executive committee consists of H. W. Maxwell, W. H. Harding, R. W. Lesley, W. R. Warren, George E. Bartol, E. N. Hagger and S. B. Newberry. A banquet was given by the Association at Sherry's, at which a silver loving cup was presented to R. W. Lesley, the retiring president.

—Westinghouse gas engines are to be adopted in a new central station now under erection at Berlin, Ontario. The initial installation will aggregate 460 horse power, comprising three 13 by 14-inch, three-cylinder, 125 horse-power, and one 11 by 12-inch, three-cylinder, 85 horse-power vertical engines. These engines will operate on city illuminating gas of 650 B. T. U. calorific value, and drive direct-current generators for furnishing municipal lighting.

The high potential transformer built by the electrical engineering department of the Worcester Polytechnic Institute, in 1898, under the direction of Professor Harold B. Smith, the head of the department, has recently been sold to Mr. C. S. Knowles of Boston, and has been sent by him to New Lexington, Ohio, for installation at that place. It will be used in connection with the High Voltage Porcelain Works in which Mr. Knowles is interested. The transformer has already been installed and is now ready for testing work. The installation was performed by Messrs. J. A. Sandford and W. T. Goddard, assistants to Professor Smith in the electrical engineering department of the Institute.

—The electrolysis-proof, bituminized-fibre, electric conduit, which the American Conduit Company introduced in California a few years ago, is now in general use there, is extensively employed in the Middle States, and is making fine progress in the East. It is used by the United States Government in the navy yards on the Atlantic and Pacific, in the War Department, in the fortifications at New London, Conn., and in the Congressional Library at Washington, D. C.; by the Chicago Telephone Company; by the Atchison, Topeka and Santa Fe Railroad; by the University of Chicago; by the Western Union Telegraph Company; by the Pennsylvania Railroad Company, and by many others. The American Conduit Company has its offices at 170 Broadway, New York; 822 Manhattan Building, Chicago, and 336 Macy St., Los Angeles, and its factories at Philadelphia, Chicago and Los Angeles, California.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine When you write.

Air Compressors.

Bulletin No. L 509, with illustrations and descriptions of a new line of air compressors of the duplex, duplex two-stage and cross-compound two-stage types, built with massive "rolling-mill" frames and fitted with the Meyer steam-valve gears, which permit of an adjustable cut-off. 9 by 6 in.; pp. 9. The Laidlaw-Dunn-Gordon Co., 116 Liberty St., New York.

Automobiles.

White Bulletin No. 2, devoted principally to accounts, with map and illustrations, of the automobile endurance run from New York to Pittsburg, nearly 800 miles, in which the White steam touring cars made a remarkably fine showing. 9¾ by 6¾ in.; pp. 16. White Sewing Machine Co., Cleveland.

Circuit Breakers.

Bulletin "C," with illustrations and descriptions of various types of the Hartman oil circuit breaker and switch, including one for electric cars, which automatically breaks an electric circuit when an overload occurs, and possesses many points of advantage. 5¾ by 4 in.; pp. 12. The Creaghead Engineering Co., Cincinnati.

Conveying Machinery.

Pamphlet No. 037, containing an introduction to the general line of machinery manufactured by the C. W. Hunt Co., including coal-hoisting towers and elevators, steam shovels, coal tubs, overhead trolleys, automatic railways, cable railways, steam and electric hoisting engines, "Stevedore" rope, coal conveyors, coal screens and valves, narrow-gauge industrial railways, electric locomotives, and other kinds of apparatus and machinery. 6 by 3½ in.; pp. 20. C. W. Hunt Company, West New Brighton, N. Y.

Cranes.

Catalogue No. 18, with illustrations of electric and hand-power traveling cranes especially designed for service in pumping stations, power stations for electric railways and large industrial plants, and lighting stations. 6 by 9 in.; pp. 16. Northern Engineering Works, Detroit.

Cylinder Oil.

Miniature book, devoted to the Eagleine special 700° cylinder oil, which has been tested by experience and is a most successful lubricant. 2½ by 2½ in.; pp. 16. Eagle Oil and Supply Co., Boston.

Dynamos.

Instruction Book No. 104, containing illustrated directions for the installation and care of direct-connected, engine-type, direct-current electric generators, with wiring diagrams. 6 by 3½ in.; pp. 26. Sprague Electric Company, 527-531 West 34th St., New York.

Electric Driving.

Catalogue No. 26, devoted to shop and tool equipments with Northern electric motors, containing handsomely illustrated descriptions of the motors, and accounts of their application to the driving of all kinds of machinery, including several reprints of articles in magazines and reports and discussions of engineering societies. 10 by 7 in.; pp. 101. Also, bulletin No. 34, illustrating and describing Northern motors operating Coffin sluice and gate valves, and booklets and leaflets devoted to various applications of these motors. Northern Electrical Manufacturing Co., Madison, Wis.

Electric Lamps.

Folder No. S. M. 4014, a booklet of suggestions for those who use incandescent lamps, containing illustrations and descriptions of Sawyer-Man incandescent electric lamps in many styles and for a great variety of purposes. 6 by 3½ in.; pp. 28. Sawyer-Man Electric Co., 510 West 23d St., New York.

Electric Lighting.

Circular, illustrating and describing an outfit for Christmas tree lighting and other decorative purposes, consisting of miniature incandescent electric lamps and of miniature sockets and lamp cord connected together and made up for immediate use. 7½ by 5¼ in.; pp. 4. General Electric Company, Harrison, N. J.

Electric Meters.

Publication No. 3197, with flexible-cloth binding, containing general data on Thomson recording wattmeters, including illustrated descriptions, connection and wiring diagrams, instructions for installation, maintenance and use, and index. 6¾ by 4¼ in.; pp. 217. General Electric Co., Schenectady, N. Y.

Engines.

Catalogue No. 62, containing a partial list of foreign users of Corliss engines, pumping engines, hoisting engines, compressors and blowing engines built by the Allis-Chalmers Company, with illustrations of some of the prominent types of these engines, which are in use in all parts of the world. 4¼ by 6 in.; pp. 78. Allis-Chalmers Company, Chicago.

Forced Draft.

Booklets, devoted, respectively, to mechanical forced draft and steel pressure blowers, with illustrations and descriptions of steel plate fans, "B" volume fans and engines, and other forced-draft and blowing apparatus. 6½ by 3½ in.; pp. 24. Also, booklet with illustrated description of the Buffalo Underwriter fire pump and the Buffalo duplex boiler feed pump. 6 by 3½ in.; pp. 4. Buffalo Forge Company, Buffalo.

Induction Motors.

Circular No. 1066, containing a description, illustrated by half tones and diagrams, of constant speed induction motors and their parts. 10 by 7 in.; pp. 12. Westinghouse Electric & Mfg. Co., Pittsburg.

Modernizing Engineers.

Bulletin No. 144, a report on Dodge & Day "betterment reports" on shop conditions, which deal with the numerous factors that, together, make up the complete manufacturing plant. This bulletin explains the Dodge & Day methods of investigating and reporting on manufacturing establishments, and contains illustrations, diagrams and descriptions which show the wide range of the work this firm has already done. 9 by 6 in.; pp. 23. Dodge & Day, Nicetown, Philadelphia.

Pile Drivers.

Bulletin No. 6, with well illustrated descriptions of a railroad pile driver, its car body, trucks, slewing frame, machinery equipment and other parts, and views showing the pile driver in its various positions. 6 by 9 in.; pp. 20. Kaltenbach & Griess, Engineers, Cleveland.

Pneumatic Tools.

Catalogue, Form No. 4, with finely illustrated descriptions of "axial-valve" pneumatic chipping and riveting hammers, duplex pneumatic "holder-on," oil rivet forge, reciprocating piston drills, and other Haeseler pneumatic tools and appliances. 9 by 6 in.; pp. 32. The Ingersoll-Sergeant Drill Co., 26 Cortlandt St., New York.

Portable Drills.

Pamphlet, with illustrations and descriptions of portable drills, adapted to a great variety of work in machine shops and other places, and operated by the Stow flexible shaft, which is driven by electric motors, pneumatic motors and in other ways. 9 by 6 in.; pp. 8. Stow Flexible Shaft Co., Frederic Schoff, Prop'r, Philadelphia.

Pumps.

"Pump Data" No. 5, a bulletin with illustrations and description of the Aldrich variable-speed triplex pump, fitted with direct-current electric motors, which are coupled to one shaft and connected to the pump through single-reduction gears. 9 by 6 in.; pp. 8. The Allentown Rolling Mills, Allentown, Pa.

Railway Materials.

Supplement to catalogue No. 77, containing additional information about the Koppel switches and turnouts and other narrow-gauge track materials, several new types of cars for special purposes, and tubs for handling material, with many illustrations. 10 by 8 in.; pp. 11. Arthur Koppel, 66-68 Broad St., New York.

Roller Bearings.

Bulletin No. 20, with fully illustrated descriptions of the Hyatt flexible roller bearing and its application to shop trucks, foundry cars and wagons, cranes, hoisting machinery, conveying machinery, glass machinery, lumber cars, transfer cars and tables, and other uses involving heavy duty at slow speed. 8¼ by 6½ in.; pp. 63. Hyatt Roller Bearing Co., Harrison, N. J.

Rotary Engines.

Bulletin No. 1, containing a well illustrated, comprehensive description of the Warren rotary steam engine, and also illustrations of direct-connected electric generating sets for power and lighting, in which the Warren engine is the prime mover. 9¾ by 6¾ in.; pp. 16. Rotary Engine Company, Philadelphia.

Screws.

Catalogue and price list with convenient marginal index and illustrated descriptions of iron and steel set screws, cap screws with various styles of head, machine screws, iron studs, coupling bolts, nuts, special brass work, and special milled work in other metals. 6¾ by 4½ in.; pp. 32. The National-Acme Manufacturing Co., Cleveland.

Steam Hammers.

Catalogue, with descriptions and illustrations from the latest photographs of ten sizes of single-frame steam hammers, in two styles, the "regular Bell," without overhanging guides, for a very wide range of blacksmith and other work, and the "standard guide," designed more particularly for forging and for working steel into shape. 10¾ by 5½ in.; pp. 20. The David Bell Engineering Works, Buffalo.

Steam Traps.

Pamphlet containing a treatise on the Bundy steam traps, of both the separating tank and the return types, giving complete accounts of their construction, operation and maintenance, with many illustrations and diagrams. 9 by 6 in.; pp. 40. A. A. Griffing Iron Co., 66-68 Centre St., New York.

Folder, with illustrated description of the Flinn steam trap, constructed on the differential principle, for draining steam pipes and steam apparatus of all kinds. This trap is especially adapted to marine and railroad use, as its action is not affected by the motion or inclination of the ship or locomotive. 5¾ by 3½ in.; pp. 6. Also, index card. Richard J. Flinn, West Roxbury, Mass.

Booklet with illustrated description of the "Komo" steam trap, which operates on any pressure and has no wearing parts except the disc, which is easily renewed. Also, price list, names of users, and testimonials. 6 by 3½ in.; pp. 22. Koehler & Monahan, New Brighton, N. Y.

Superheaters.

Catalogue, containing an essay on superheated steam, with diagrams and useful tables, and an illustrated description of the Foster patent superheater, with types of superheater settings. 9 by 6 in.; pp 16. Power Specialty Co., 126 Liberty St., New York.

Wood-Working Machinery.

Pamphlet, with list of second-hand wood-working machines, including lathes, matchers, molders, mortisers, sanders, saws, surfacers, tenoners, dovetailers, and other kinds, thoroughly adjusted and in first-class working order. 5¼ by 6½ in.; pp. 16. J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati.

IMPROVED MACHINERY

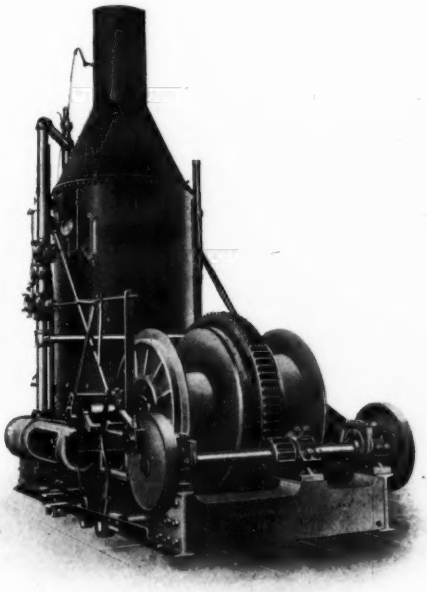
New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Willamette Logging Engine.

THE new type of logging engine illustrated herewith has been particularly designed to meet the demands for rapid yarding of the heavy timber of the Northwest. These logs are frequently seven or eight feet in diameter, and are sometimes cut in lengths up to forty feet. A log of this size dragged hap-hazard over the roughest country imaginable requires the most powerful machinery and cables, and the machine in question carries a one-inch plow-steel cable on the main haul and a five-eighths inch on the re-haul.

Not only must these engines be capable of handling such timber, but in moving in the roughest kind of locations they are solely dependent upon their own motive power. In order to facilitate this moving, they are generally mounted upon sleds made up of two runners about 32 feet long and of 24 by 26-inch timbers, securely cross-timbered and bound together by 1½-inch bolts. Mounted on such a sled, convenient stumps and trees are used for anchor points and the engine pulls itself over the country, sometimes ascending grades which look almost hopeless, in such cases it being necessary, of course, to pass the cable through blocks to increase the pulling power.



WILLAMETTE LOGGING ENGINE.

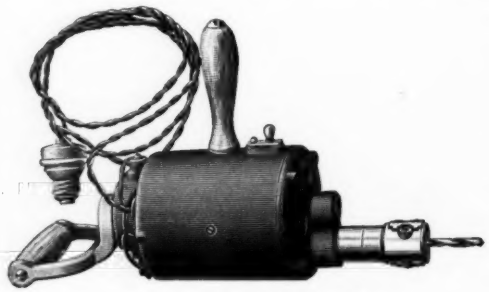
The advantages of having both drums located on a single shaft are in the reduc-

tion of parts, and in the narrow large body drums, which make the cable service very much easier and also make it possible to lead the cable from what is known as a "fair leader," which is placed on the end of the sled.

The proportions of these engines must be such as to give the greatest possible rigidity, and hence freedom from breakage, as the locations in which they are used are reached with such difficulty that a breakdown is a very serious matter.

The weight of this engine is ten tons and its pulling capacity on a straight line about the same amount. Its cylinders are 9½ by 11 inches. These proportions confine its operation to that of yarding up to distances of 1,500 feet, and in the case of the longer hauls necessary for road engines, which are frequently called upon to haul one mile or more, the design of engine is different, on account of the demands for greater drum capacity, etc. Those road engines are frequently built with cylinders as large as 14 by 14 inches, and carry 72-inch boilers, the machine having a total weight of over twenty tons. Machines of this kind must also be able to handle themselves in the woods and the necessity for strength and compactness is most apparent.

Any further information concerning these engines will be cheerfully furnished by the manufacturers, the Willamette Iron & Steel Works, of Portland, Oregon.



HISEY-WOLF PORTABLE DRILL.

Portable Electric Hand Drill.

AMONG the latest and most useful applications of electricity to the operation of tools is the Hisey portable electric hand or breast drill, which is herewith illustrated, for drilling holes in metal or wood. It is designed to take the place of the old style hand drill, and is driven at a much higher speed, without making any demands upon the strength of the operator. Being light in weight, it can be carried anywhere, and its range of operation is practically unlimited, as any desired length of electric conductor can be used.

The motor is enclosed, and is dust and dirt proof. It is suitably geared to develop the necessary power up to the capacity of the drill. It is under perfect control of the operator at all times, as a switch is provided to start and stop it. This is located near the vertical handle, as shown in the illustration, and is easily reached by the index finger. The case has two handles, by means of which the tool can be held in any desired position. Power is derived from any direct-current circuit, of 110 or 220 volts pressure, and attachment can be made to any incandescent lamp socket.

These drills are made in three sizes, capable of drilling up to ¼-inch, ⅜-inch and ½-inch holes, and weighing 14, 16 and 27 pounds, respectively.

They are sent out complete, ready for work, and have no belt connections of any kind. They can be used in any part of a shop, thus doing away with bringing the work to a drill press. Any further information desired concerning these tools will be gladly furnished by the Hisey-Wolf Machine Company, of Cincinnati.

Electric Crane for Freight Yards.

THE latest type of an approved and economical apparatus for the handling of heavy and bulky freight in a railroad yard is illustrated in the accompanying view, which shows a portion of the yard of the Buffalo & Allegheny Division of the Pennsylvania Railroad Company, and includes a 40-ton Niles overhead electric traveling crane, of 48 feet span, and a substantial structural steel runway 40 feet long. The crane spans three tracks, and leaves a wide passageway, which gives ample approach for teams and trucks on one side of the cars covered by this apparatus.

In addition to the main hook, a quick running auxiliary hook of 5 tons' capacity, which performs by far the greater part of the service of the crane, is provided for the rapid and efficient handling of light loads.

The bridge consists of two heavy, curved girders, of box section. It is driven longitudinally on the runway by a motor located on the front girder which is geared to the truck wheels on either side, the motion being controlled by a foot brake located in the operator's cage, which acts directly upon the armature shaft of the motor.

A foot bridge is provided the entire length of the span, with the customary guard rail. The bridge trucks are of the built-up type, securely fastened, with the utmost rigidity, to the girders, and provided with heavy cast-steel, double-flanged truck wheels with treads accurately finished to uniform diameter.

The trolley is of the standard type used on overhead cranes, consisting of heavy side frames securely bolted together and kept in perfect alignment by a separator. All the gearing is cut from the solid and runs encased in oil, which gives the entire mechanism an unusually high mechanical efficiency. Both hoists are provided with mechanical and electric brakes, and also with circuit breakers and limit switches to prevent overwinding and consequent damage to the crane or its load. The trolley, operator's cage, and bridge-drive motor are of the inclosed type, affording suitable protection from the weather. The runway, it will be noticed, is of substantial construction. It consists of four built-up columns carrying runways of riveted plate and channel construction, laterally braced by overhead struts and chords of lattice construction.

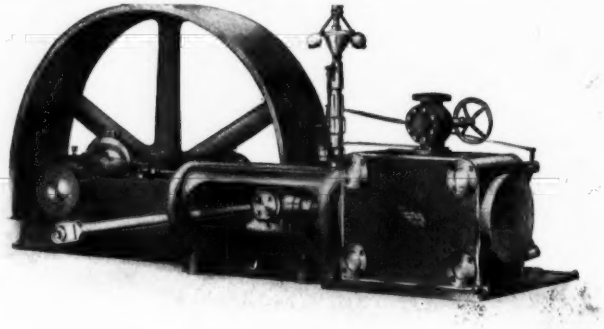
NILES OVERHEAD ELECTRIC TRAVELING CRANE.

It will be readily appreciated that an equipment of this character has a much greater capacity than the average pillar or

swinging crane which is usually installed at railroad freight stations where any crane is in use.

If at any time it is desired to cover increased acreage by the hook, the length of runway is readily increased by adding additional spans. This crane is notable because of the extra height of lift, which enables the loaded hook to clear the top of box cars or other obstructions while performing the functions of its regular service of loading and unloading.

The complete apparatus was manufactured, installed, and erected by the crane department of the Niles-Bement-Pond Company, Meadow and Mifflin Streets, Philadelphia, which will gladly furnish any additional information that may be desired.



REYNOLDS-CORLISS STEAM ENGINE.

New Standard Reynolds-Corliss Engine.

A NEW Corliss engine, which is being brought out by the Allis-Chalmers Company from the designs of Irving H. Reynolds, is illustrated herewith. The field of Corliss engine design has been so fully worked over in the past, and the accepted designs have become so simple, that no strikingly novel features are to be expected. The present machine, however, represents the experience of twenty-six years in the building of Corliss engines, and combines all of the desirable elements of the best designs.

Engines of the type shown are being built in seven sizes, ranging from 50 to 500 horse power, and are designed for steam pressures up to 150 pounds. They are of somewhat shorter strokes than have heretofore been customary in Corless engines, with the idea of economizing in space and making the construction more rigid. The speeds are also somewhat higher than usual, ranging from 110 to 150 revolutions per minute, although these speeds are not higher than those at which the Reynolds-Corliss engines of older design are frequently operated.

The frame is cast in one piece with the slide, the construction being of the box type, resting on the foundation for its entire length. The main bearing shells are bored into the frame, thus insuring a solid bearing and also permitting the easy removal of the shells by rolling them out around the shaft.

The slide is of the barrel type with bored guides. The crosshead is fitted with babbitt-faced shoes with wedge adjustment. The piston rod is screwed into the crosshead and held firmly with a steel lock nut. The cylinder is of the round-cornered type, and is fitted with double ported steam and exhaust valves, lagged with planished steel. The cylinder is set on a cast-iron base plate, which extends under the valve gear, serving as a drip pan.

The valve gear is of the usual Reynolds-Corliss type, the wrist plate being of skeleton pattern and fitted with a new type of disconnecting device which, while clamping the hook rod firmly, is very easily detached by hand.

The dash pots are of differential plunger type, without leathers or packing of any kind. The regulator is of the high-speed weighted type, designed to control the engine within narrow limits of speed variation.

The connecting rod is of steel with solid

forged ends, fitted with bronze boxes, babbitt lined on the crank-pin ends, the boxes being adjustable by means of screw actuated wedges. The crank is of plain type, polished on the face, and is protected by a planished steel oil guard.

The engines are fitted either with belt fly wheels, as shown, or with square-rim wheels where used with direct connected electric generators. The crank and cross-head pins and main journals are of a size ordinarily used with heavy-duty engines.

In brief, the engine is strong, simple and compact, and while nothing has been added for ornamentation, nothing contributing to economy or durability has been omitted, and the machine should find a large sale among power users who appreciate quality.

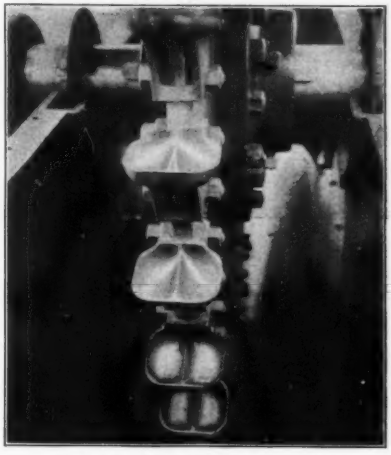
Any further information which may be desired will be gladly given by the Allis-Chalmers Company, Chicago.

Pelton Water Wheels.

THE constantly increasing development of hydraulic electric traction enterprises, resulting from the thoroughly reliable and standardized electric apparatus now obtainable, and the high cost of fuel in districts where water powers are most readily obtainable, has brought about the rapid development of the tangential water wheel with its accessory apparatus, resulting in prime movers of this class far in advance of those obtainable in the old mining days. There can be nothing more reliable for continuous duty and no piece of machinery more free from repairs than a modern Pelton wheel. The requirements of modern practice for a highly efficient, all-day load, as distinguished from merely a high normal-load efficiency, have made the introduction of a thoroughly reliable regulating nozzle necessary.

The old type of the Clemmon's nozzle with some modification has proven itself well adapted for this work, and, as built by the Pelton Water Wheel Co. in combination with a deflecting nozzle, is an ideal device for use in securing most accurate speed control and at the same time, the highest water economy. Some idea of the perfect control of the stream cross section is obtained from the illustration on the next page, which shows the shape of the stream issuing from a Pelton needle nozzle.

Special cases occur where more than one stream is used to develop the output from one unit. For instance, in one of the illustrations is shown a double Pelton unit where two separate pipe lines, under different pressures, are used on two separate wheels of different diameter mounted on the same shaft. This unit is in use at the plant of the Ophir Light & Power Co., of Utah, and one of the wheels is equipped



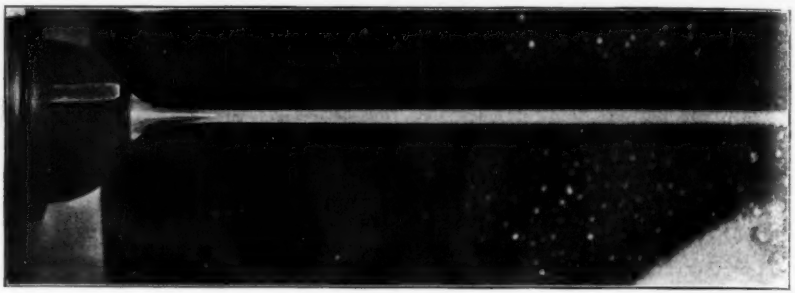
PELTON WATER-WHEEL BUCKETS.

with a double nozzle, on one outlet of which a needle regulating tip and stream deflector are provided, and on the other a stream deflector only. This arrangement secures accurate regulation over the entire range of load and water supply regulation to 1/3 load, and so enables the water flow at various seasons to be used most economically. The second wheel is provided with a deflecting nozzle only. Each wheel is, of course, also provided with a gate valve.

The recent development of large capacity, high-speed generators for use with steam turbines has made large high-speed bearings a necessity and these frequently are called upon to carry very heavy rotor weights.

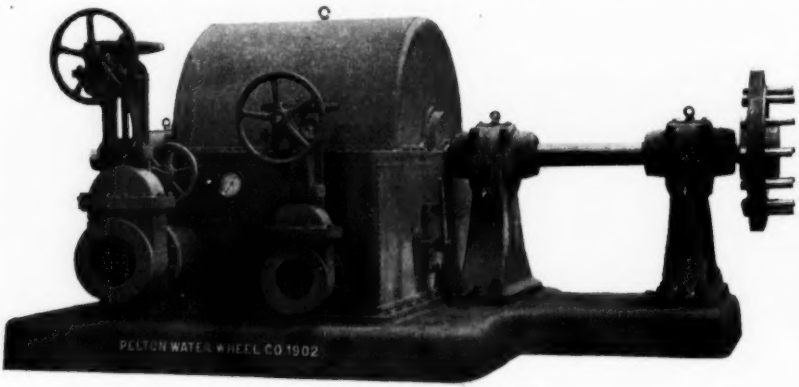
Ring-oiling bearings of every size, and designed for the most severe conditions, and provided with electric thermostats and water circulation, as well as with forced high-pressure oil circulation, are being manufactured by the Pelton Water Wheel

Co. for all large direct-connected units. In order to keep down the floor space, wheels are often overhung on each end of a shaft which is carried in two bearings, between which is located an engine-type generator. Shafts of maximum rigidity are required for this, hence hollow, nickel-steel, fluid-compressed shafts are being widely used.



STREAM FROM PELTON NEEDLE NOZZLE.

The greatest interest in the design of a tangential water wheel usually attaches to the bucket. These should be designed specially for each set of conditions, the shape for best results varying considerably. The Pelton Company have brought out many shapes, each for use in a particular field. The latest high-head type (covered by a Henry patent) is shown in one of the illustrations, which represents a portion of the rim of the Pelton wheel at the station of the Edison Electric Co., of Los Angeles, Cal. This wheel developed a full-load efficiency of over 86 per cent. One of the buckets was painted with asphaltum varnish and that portion of the varnish still remaining shows how evenly the water flows over the interior surface. This wheel runs at 430 revolutions per minute and the stream strikes the buckets with a pressure of over 5 tons for a portion of the time during each revolution. This gives some idea of the excessive stresses to which the machinery is subjected, and of the accuracy and superiority of the workmanship and the high grade material necessary to furnish a reliable and efficient service for 24 hours a day and 365 days in the year.



PELTON DOUBLE WATER-WHEEL UNIT.

Further information regarding their water wheels and other hydraulic apparatus will be gladly furnished by the Pelton Water Wheel Co., of San Francisco.